Department of Environmental Quality
INL Oversight Program

ENVIRONMENTAL SURVEILLANCE PROGRAM QUARTERLY DATA REPORT

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Boise Office
1410 N. Hilton
Boise, Idaho 83706
208-373-0428

Idaho Falls Office
900 N. Skyline, Suite B
Idaho Falls, Idaho 83402
208-528-2600

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Table of Acronyms

aCi/L	-	attocuries per liter
ATR	-	Advanced Test Reactor
BEA	-	Battelle Energy Alliance, LLC
BLR	-	Big Lost River
CERCLA	-	Comprehensive Environmental Response, Compensation and Liability Act
CFA	-	Central Facilities Area
CFR	-	Code of Federal Regulations
CITRC	-	Critical Infrastructure Test Range Complex
DEQ-INL OP	-	The State of Idaho, Department of Environmental Quality, Idaho National Laboratory Oversight Program
DOE	-	U.S. Department of Energy
EBR I & II	-	Experimental Breeder Reactors I & II
EFS	-	Experimental Field Station
EIC	-	electret ionization chamber
EML	-	Environmental Monitoring Laboratory
EPA	-	Environmental Protection Agency
ESER	-	Environmental Surveillance, Education and Research Program
ESP	-	Environmental Surveillance Program
ESRPA	-	Eastern Snake River Plain Aquifer
Ft bls	-	feet below land surface
HPIC	-	high-pressure ion chamber
IBL	-	Idaho Bureau of Laboratories
ICPP	-	Idaho Chemical Processing Plant
IDL	-	instrument detection limit
INL	-	Idaho National Laboratory
INTEC	-	Idaho Nuclear Technology and Engineering Center
ISU	-	Idaho State University
LLD	-	lower limit of detection
LSC	-	liquid scintillation counting
MCL	-	maximum contaminant level
MDA	-	minimum detectable activity
MDC	-	minimum detectable concentration
MFC	-	Materials and Fuels Complex
µg/L	-	micrograms per liter
mg/L	-	milligrams per liter
MP	-	milepost
mrem	-	millirem or 1/1000th of a rem
mR	-	milliRoentgen
mR/hr	-	milliRoentgen per hour
µR/hr	-	microRoentgen per hour
MV	-	Magic Valley
NIST	-	National Institute of Standards and Technology
nCi/L	-	nanocuries per liter
NCRP	-	National Council on Radiation Protection and Measurements
NOAA	-	National Oceanic and Atmospheric Administration
NRF	-	Naval Reactors Facility
PBF	-	Power Burst Facility
pCi/g	-	picocuries per gram
pCi/L	-	picocuries per liter
pCi/m^3	-	picocuries per cubic meter
QAPP	-	Quality Assurance Program Plan
QA/QC	-	Quality Assurance/Quality Control
RCRA	-	Resource Conservation and Recovery Act
RPD	-	relative percent difference
RTC	-	Reactor Technology Complex
RWMC	-	Radioactive Waste Management Complex
SD	-	Sample standard deviation
SMC	-	Specific Manufacturing Capability
SMCL	-	secondary maximum contaminant level
TAN	-	Test Area North
TDS	-	total dissolved solids
TMI	-	Three Mile Island
TRA	-	Test Reactor Area
TSP	-	total suspended particulate
TSS	-	total suspended solids
USGS	-	U.S. Geological Survey
VOC	-	volatile organic compound
WLAP	-	Wastewater Land Application Permit

Introduction

The State of Idaho, Department of Environmental Quality, Idaho National Laboratory Oversight Program (DEQ-INL OP) conducts an Environmental Surveillance Program (ESP) at locations on the INL, near the boundaries of the INL, and at distant locations to the INL in accordance with accepted monitoring procedures and management practices. This program is designed to provide the people of the state of Idaho with independently evaluated information about the impacts of the Department of Energy's (DOE) activities in Idaho.

The primary objective for DEQ-INL OP's ESP is to maintain an independent environmental monitoring and verification program designed to verify and supplement DOE's environmental data and programs. This program also provides the citizens of Idaho with information on current and proposed DOE programs that has been independently evaluated to enable them to reach informed conclusions about DOE activities in Idaho and potential impacts to public health and the environment.

Results of the ESP are published using two distinct reporting formats: quarterly data reports and an annual ESP report. The annual ESP report is designed for a broad audience and summarizes the results of the ESP for the previous four quarters. The annual report's primary emphasis is to focus on trends, ascertain the impacts of DOE operations on the environment, and confirm the validity of DOE monitoring programs. This quarterly report is designed to document the results of the ESP on a quarterly basis and provide detailed data. It is organized according to the media sampled and also provides a quality assurance assessment.

Air and Precipitation Monitoring Results

The ESP operated eight air monitoring stations on and near the INL as well as two monitoring stations distant from the INL during the fourth quarter, 2019 (**Figure 1**). These stations employed instrumentation for collecting airborne particulate matter, gaseous radioiodine, precipitation, and water vapor for tritium analysis (**Table 1**). The Shoshone-Bannock Tribes operated an air monitoring station located at Fort Hall. The Fort Hall station uses identical instrumentation and sampling protocol as the ten stations operated by the ESP. The DEQ-INL OP reports the Fort Hall station data as an additional distant site.

Airborne particulate matter was sampled using high-volume total suspended particulate (TSP) air samplers. Weekly gross alpha and gross beta particulate radioactivity results for filters from the TSP samplers are presented in **Appendix A** and summarized as a range of results in **Table 2**. Results are within the expected historical

Composites of filters collected using TSP samplers during the course of a calendar quarter are analyzed using gamma spectroscopy. Typically, gamma spectroscopy results are only reported when exceeding a minimum detectable activity (MDA) or minimum detectable concentration (MDC). Gamma spectroscopy results for the fourth quarter of 2019 for TSP filters are presented in **Table 3**. Beryllium-7, a naturally occurring, cosmogenic radionuclide was seen at all locations. Cesium-137, a man-made radionuclide, was detected at the same value as the MDC at the Experimental Field Station, but was well below the INL OP action level of 1.9×10^{-3} pCi/m^3.

Radioactive iodine samples are collected weekly. Samples are collected by drawing air through a canister filled with activated charcoal using a low-volume air pump. The activated charcoal contained in the canister traps the radioiodine by adsorption onto its porous surface. Each week, canisters are collected from all eleven air monitoring stations and analyzed together as a composite. If Iodine-131 is detected in this grouping, the canisters are individually analyzed. No radioactive isotopes of iodine, specifically

Iodine-131, were detected on the weekly charcoal cartridges used to collect this nuclide during the fourth quarter.

Atmospheric moisture was collected by drawing air through hygroscopic media at each of the 11 monitoring stations. This moisture was stripped from the hygroscopic media and analyzed to calculate the atmospheric tritium concentration. Reported values are the result of either a single sample or a weighted mean based upon the volume of air sampled when more than one atmospheric moisture sample was collected during the calendar quarter. All results are below MDCs and below the DEQ-INL OP action level of 150 pCi/m^3 (40 CFR 61). Average atmospheric tritium concentrations are presented in **Table 4**.

Precipitation samples were collected at six monitoring locations during the fourth quarter of 2019. Precipitation samples were analyzed for tritium and manmade gamma-emitting radionuclides. Reported values were either the result of a single sample or a weighted mean when more than one precipitation sample was collected during the calendar quarter. Tritium and manmade gamma-emitting radionuclides were below minimum detectable concentration in precipitation collected during the fourth quarter of 2019. Analysis results for Tritium (H-3) and Cesium-137, the most likely to be detected of manmade gamma-emitting radionuclides, are presented in **Table 5**.

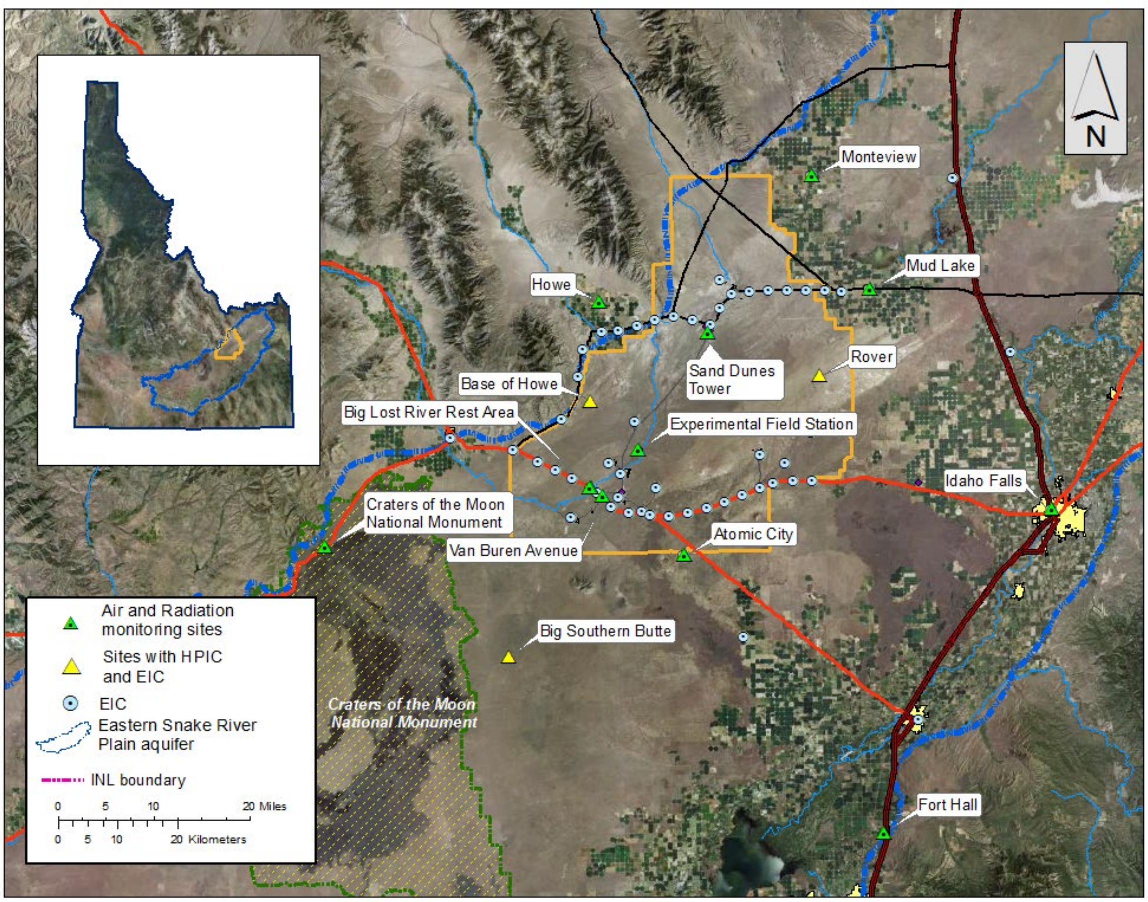

Figure 1. Air and radiation monitoring locations.

Table 1. Sampling locations and sample type

Station Locations	Sample type[1]			
	TSP	Radioiodine	Water Vapor	Precipitation
On-site Locations				
Big Lost River Rest Area	□	□	■	■
Experimental Field Station	□	□	■	
Sand Dunes Tower	□	□	■	
Van Buren Avenue	□	□	■	
Boundary Locations				
Atomic City	□	□	■	■
Howe	□	□	■	■
Monteview	□	□	■	■
Mud Lake	□	□	■	■
Distant Locations				
Craters of the Moon	□	□	■	
Fort Hall[2]	□	□	■	
Idaho Falls	□	□	■	■

[1] □Samples collected weekly; ■ Samples collected quarterly.
[2]TSP and radioiodine samples collected by Shoshone-Bannock Tribes.

Table 2. Range of gross alpha and gross beta concentrations for TSP filters, fourth quarter, 2019.

Station Location	Concentration					
	Gross Alpha			Gross Beta		
On-Site Locations						
Big Lost River Rest Area	0.5	-	1.3	21.6	-	64.8
Experimental Field Station	0.8	-	2.4	18.0	-	167.8
Sand Dunes Tower	0.3	-	1.1	14.3	-	45.6
Van Buren Avenue[2]	0.3 J	-	1.0 J	16.8 J	-	41.9 J
Boundary Locations						
Atomic City	0.5	-	2.3	23.3	-	82.0
Howe	0.4	-	1.0	14.0	-	37.7
Monteview	0.5	-	1.6	17.7	-	51.2
Mud Lake	0.7	-	2.3	21.8	-	72.2
Distant Locations						
Craters of the Moon	0.3	-	0.8	12.0	-	30.5
Fort Hall[1]	0.7	-	2.1	22.5	-	66.9
Idaho Falls	0.6	-	2.7	21.0	-	101.0

[1]Operated by Shoshone-Bannock Tribes.
[2]Sampler was calibrated and flowmeter was found to be incorrect. All values were re-calculated based on the calibration data and qualified as estimates (J).
Note: Concentrations are expressed in 1 x 10^{-3} pCi/m^3.

Table 3. Gamma spectroscopy analysis data for TSP filters, composite samples, fourth quarter, 2019.

Station Location	Naturally Occurring Radionuclide Beryllium-7		Man-Made Gamma Emitting Radionuclides	
	Concentration	± 2 SD	Concentration	MDC
On-site Locations				
Big Lost River Rest Area	77.1	4.1	<MDC[2]	
Experimental Field Station	114.8	6.2	0.08[3]	0.08
Sand Dunes Tower	53.8	3.0	<MDC	
Van Buren Avenue	194.8	10.4	<MDC	
Boundary Locations				
Atomic City	88.0	4.7	<MDC	
Howe	50.2	2.9	<MDC	
Monteview	61.9	3.4	<MDC	
Mud Lake	75.4	4.1	<MDC	
Distant Locations				
Craters of the Moon	50.1	2.8	<MDC	
Fort Hall[1]	105.0	5.7	<MDC	
Idaho Falls	95.3	5.2	<MDC	

[1]Operated by Shoshone-Bannock Tribes.
[2]MDC for Cs-137 typically (0.05-0.10) x 10^{-3} pCi/m^3.
[3]Cs-137 was detected at the same value as the MDC.
Note: Concentrations are reported in 1 x 10^{-3} pCi/m^3 with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).

Table 4. Tritium concentrations in air from atmospheric moisture, fourth quarter, 2019.

Station Location	Tritium		
	Concentration	± 2 SD	MDC
On-site Locations			
Big Lost River Rest Area	0.09	0.08	0.13
Experimental Field Station	0.23	0.22	0.37
Sand Dunes Tower	0.03	0.19	0.32
Van Buren Avenue	0.04	0.18	0.30
Boundary Locations			
Atomic City	0.09	0.21	0.35
Howe	-0.01	0.11	0.19
Mud Lake	0.04	0.21	0.35
Monteview	0.11	0.21	0.35
Distant Locations			
Craters of the Moon	0.03	0.17	0.30
Fort Hall[1]	0.23	0.25	0.41
Idaho Falls	0.07	0.23	0.40

[1]Operated by Shoshone-Bannock Tribes.
Note: Concentrations are reported in pCi/m^3 with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).

Table 5. Tritium and gamma-emitting radionuclide concentrations from precipitation, fourth quarter, 2019.

Station Location	Tritium			Cesium-137		
	Concentration	± 2 SD	MDC	Concentration	± 2 SD	MDC
On-site Locations						
Big Lost River Rest Area	50	90	160	0.9	1.5	2.5
Boundary Locations						
Atomic City	30	100	160	1.4	1.7	2.9
Howe	50	90	160	0.0	1.1	1.9
Monteview	0	100	160	0.2	1.5	2.5
Mud Lake	-80	90	160	1.4	1.5	2.5
Distant Locations						
Idaho Falls	-30	90	160	0.1	1.6	2.7

Note: Concentrations are reported in pCi/L with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).

Environmental Radiation Monitoring Results

The ESP operated 13 environmental radiation stations during the fourth quarter of 2019 (**Figure 1**). To detect gamma radiation, each station is instrumented with triplicate electret ionization chambers (EIC), and 10 of the stations also are equipped with a high-pressure ion chamber (HPIC) or EcoGamma dual Geiger–Müller gamma radiation monitor. (**Table 6**).

The Shoshone-Bannock Tribes operate an air monitoring station at Fort Hall which is also equipped with EICs and an HPIC, both of which are owned and operated by the DEQ-INL OP. The DEQ-INL OP reports these results as a distant site.

HPICs and EcoGammas are instruments capable of real-time measurements, and are sensitive enough to detect small changes in gamma radiation levels. The real-time gamma radiation measurements collected by the HPICs and EcoGammas at each location are radioed to DEQ-INL OP and presented graphically via the worldwide web at http://www.deq.idaho.gov/inl-oversight/monitoring/gamma-radiation-measurements.aspx.

EICs are a passive-integrating system that provides a cumulative measure of environmental gamma radiation exposure in the field. EICs are deployed, collected, and analyzed quarterly. EICs offer an inexpensive methodology to measure gamma radiation over a wide area, particularly in regions which do not have a power source. EICs can also provide valuable gamma radiation data in the event of an emergency. For this reason, EICs are deployed at 67 locations by DEQ-INL OP in a widespread network around the INL measuring external radiation. This information is tabulated in **Appendix B.**

These two systems are used by DEQ-INL OP to measure external gamma radiation for various radiological monitoring objectives. **Table 7** lists the average radiation exposure rates measured by the HPICs for fourth quarter 2019. **Table 8** lists the EIC monitoring results for fourth quarter 2019. Overall exposure rates were within the expected historical range of values observed by DEQ-INL OP for background radiation.

Table 6. Summary of instrumentation at radiation monitoring stations.

Station Location	Instrument Type	
	HPIC	EIC
On-site Locations		
Base of Howe	■	■
Big Lost River Rest Area	■	■
Experimental Field Station		■
Rover	■	■
Sand Dunes Tower	■	■
Van Buren Avenue		■
Boundary Locations		
Atomic City	■	■
Big Southern Butte	■	■
Howe Met Tower	■	■
Monteview	■	■
Mud Lake/Terreton	■	■
Distant Locations		
Craters of the Moon		■
Fort Hall	■	■
Idaho Falls	■	■

Table 7. Average gamma exposure rates, fourth quarter, 2019, from HPIC* network.

Station Location	Exposure Rate (μR/hr)	
	Quarterly Average	± 2 SD
On-site Locations		
[1]Base of Howe	-	-
Big Lost River Rest Area	13.7	1.9
[1]Rover	-	-
Sand Dunes Tower	16.0-	2.1-
Boundary Locations		
Atomic City	14.7	1.4
[1]Big Southern Butte	-	-
Howe Met Tower	13.1	1.4
Monteview	13.4	1.6
Mud Lake / Terreton	16.2	1.6
Distant Locations		
Fort Hall	12.9	0.9
Idaho Falls	12.2	2.3

[1]No data available for these locations for fourth quarter 2019 due to electronic malfunctions / failures in instrumentation.
*The HPIC's are sensitive electronic devices that can experience intermittent malfunctions and/or interference, this typically results in characteristic positive and/or negative data spikes. These aberrations are removed from the data set based on the judgement of the data analyst.

Table 8. Electret ionization chamber (EIC) cumulative average exposure rates, fourth quarter, 2019.

Station Location	Exposure Rate (μR/hr)	
	Quarterly Average[1]	± 2 SD
On-Site Locations		
Base of Howe	13.2, 13.4	-
Big Lost River Rest Area	14.8	1.8
Experimental Field Station	12.7, 13.5	-
Rover	17.9, 18.0	-
Sand Dunes Tower	14.1	3.0
Van Buren Avenue	15.0, 17.0	-
Boundary Locations		
Atomic City	13.0, 16.2	-
Big Southern Butte	9.5, 11.0	-
Howe Met Tower	12.2	2.1
Monteview	12.5, 13.6	-
Mud Lake/Terreton	13.3	3.2
Distant Locations		
Craters of the Moon	12.5	1.9
Fort Hall	12.5, 14.1	-
Idaho Falls	12.3	2.6

[1]Results are the average of triplicate exposure rate measurements with the associated sample variability (±2 SD), or the 2 measured exposure rates remaining after removal of an outlying value. One of the triplicate measurements is rejected if it is outside the average of the triplicate measurements ±2 SD of the historical population variability. Typically, the two most consistent measurements are reported, based on judgment of the data analyst.

Water Monitoring Results

DEQ-INL OP collects groundwater samples from wells and springs located within, upgradient of, and downgradient of the INL in order to evaluate the effects of INL contaminants on water quality in the eastern Snake River Plain (ESRP) aquifer and verify the results of DOE and USGS monitoring. Each year, DEQ-INL OP samples approximately 80-85 locations concurrently with a DOE contractor or the USGS and 15-20 locations independently. Co-sampled locations are primarily on or near the INL Site and are usually sampled during the third and fourth calendar quarters. DEQ-INL OP publishes a comparison of its own analytical results with those obtained by co-samplers in the DEQ-INL Oversight Program Annual Report. Locations sampled independently by DEQ-INL OP are mostly in the Magic Valley and are typically sampled during the third calendar quarter.

Most water samples are collected from wells drilled into the aquifer or springs formed by the intersection of the aquifer water table with the surface. Each aquifer well or spring is categorized as upgradient, facility, boundary, or distant based on its location (**Figure 2** and **Figure 3**):

- *Upgradient* sites are situated north or northeast of INL facilities in areas that have not been affected by INL operations. They are used to monitor background concentrations in the aquifer.

- *Facility* sites are located near facility complexes within the INL, including the Advanced Test Reactor complex (ATR), the Central Facilities Area (CFA), the Idaho Nuclear Technology and Engineering Center (INTEC), the Materials and Fuels Complex (MFC), the Naval Reactors Facility (NRF), the Radioactive Waste Management Complex (RWMC), and Test Area North (TAN). Facility sites are located within or immediately downgradient of known areas of

contamination and are sampled to monitor the concentrations and migration of specific contaminants.

- *Boundary* sites are located near the southern boundary of the INL, downgradient of potential sources of INL contamination. These include several wells equipped with Westbay Multilevel Groundwater Monitoring Systems ("Westbay wells"), which offer a look at the vertical distribution of constituents in the aquifer.

- *Distant* sites are located farther downgradient of the INL, primarily in the Magic Valley, and include wells and springs used for agricultural, municipal, domestic, and industrial purposes.

A small number of samples are also collected each year from streams, waste-pond effluent, and wells drilled into perched groundwater (groundwater that sits above the aquifer).

Samples collected from water-monitoring sites are analyzed for radiological and non-radiological constituents, many of which are present in the aquifer both naturally and as a result of INL operations. All locations are sampled for gross alpha and gross beta radioactivity, manmade gamma-emitting nuclides, tritium, common ions,[1] and nitrate-plus-nitrite.[2] Samples from locations at which tritium concentrations are too low to be detected by the standard method are re-analyzed for tritium using an electrolytic enrichment method (referred to as the low-level method), which has a minimum detectable concentration (MDC) about ten times lower than the standard method. Selected sites are also sampled for specific radionuclides—including uranium isotopes (^{234}U, ^{235}U, and ^{238}U), plutonium isotopes (^{238}Pu, $^{239/240}$Pu), americium-241 (^{241}Am), strontium-90 (^{90}Sr), and technetium-99 (^{99}Tc)—selected trace metals, total phosphorous, and/or volatile organic compounds (VOCs) based on past and present INL operations or a history of elevated concentrations. If unexpected levels of radioactivity are detected in gross measurements, additional samples will be collected and analyzed for specific radionuclides.

During the fourth quarter of 2019, DEQ-INL OP sampled groundwater from the aquifer at 11 facility locations, four boundary locations, two distant well locations, three distant spring locations, one wastewater location, and one upgradient location, and one surface water location. Four locations were also sampled from the perched groundwater near ATR. **Table 9** lists the sample date, co-sampler, well depth, and analyses requested for the locations sampled this quarter. Analytical results are reported in **Tables 11 through 21** and summarized below. The results of low-level tritium analyses for 20 samples collected in previous quarters are reported in **Table 13** and discussed below.

Table 10 shows the range of background concentrations for each constituent in the ESRP aquifer and the EPA drinking water maximum contaminant level (MCL) or secondary MCL. Background concentrations depend on local geology, and the concentrations of constituents at sites not influenced by INL activities may on occasion be higher than the given background ranges due to local factors and natural variability.

Gross alpha and gross beta radioactivity

Gross alpha and gross beta analyses are used to screen for unexpectedly high levels of radioactivity in samples. DEQ-INL OP has determined from past sampling that background concentration ranges for gross alpha and gross beta radioactivity in the ESRP aquifer are approximately 0-5.6 pCi/L and 0-8.6 pCi/L, respectively. Occasional measurements of concentrations above these background ranges in uncontaminated samples are statistically probable due to uncertainties inherent in measuring low levels of radioactivity. Additionally, some samples will have levels of radioactivity slightly higher than

[1] The common ions are calcium, magnesium, potassium, sodium, chloride, fluoride, sulfate, and bicarbonate (reported here as alkalinity).
[2] Distant locations Alpheus Spring, Bill Jones Hatchery, Clear Spring, Minidoka Water Supply, and Shoshone Water Supply and upgradient location Mud Lake Water Supply are sampled only for gross alpha and gross beta radioactivity, gamma-emitting radionuclides, and tritium during the third and fourth quarters. Samples for common ions, nitrate-plus-nitrate, and other constituents are collected at these locations during the third quarter.

background ranges due to higher-than-average concentrations of naturally occurring uranium, thorium, or potassium-40.

Gross alpha and beta radioactivity were detected at low levels in most samples. Gross alpha radioactivity was measured at concentrations within the known background range in all but an ATR perched water location PW-9. While expected based on past results, this is likely attributed to increased migration of radionuclides from the vadose zone due to recent snow melt and precipitation. Elevated gross beta concentrations were measured at ATR perched water locations PW-9, USGS-073, and PW-12. PW-12 is a new well added to the program based on recent ICP contractor reports of spikes in tritium results. The elevated gross beta is consistent with the ^{90}Sr result discussed below. Other elevated gross beta results were measured at TAN well TAN-10A and INTEC wells USGS-112 and USGS-115 and are consistent with known ^{90}Sr or ^{99}Tc contamination in each of these wells. All other detectable concentrations in groundwater were consistent with historical trends.

Manmade gamma-emitting radionuclides

No manmade gamma-emitting radionuclides were detected at the locations sampled this quarter. Results for cesium-137 (^{137}Cs), the manmade gamma-emitter most likely to be detected in groundwater, are reported in **Table 11**.

Tritium

Tritium was measured at all locations sampled this quarter (**Table 12**). Elevated tritium concentrations were observed in aquifer wells at or near ATR, INTEC, RWMC, TAN, and near the southern INL boundary at USGS-104. High concentrations were also measured in perched water at ATR. Elevated tritium concentrations ranged from 330 ± 110 to 13,390 ± 380 pCi/L with the highest being that from perched water well PW-12. This high result is consistent with the ICP contractor report[3] result of 13,000 ± 1,310 pCi/L.

The contractor report indicates that the cause of elevated tritium in well PW-12 is uncertain and that an investigation of potential tritium sources will be undertaken, with results reported in their FY 2020 monitoring report. All other elevated tritium concentrations were consistent with past results with most indicating a decreasing trend.

Three samples from this quarter requiring low-level tritium analysis have been analyzed. All others will be delayed due to a sample backlog. The other results presented in **Table 13** include 12 samples from 2nd quarter 2019 and five from 3rd quarter 2019. Four samples are from boundary wells, six are from facility wells, and the remaining 10 are from distant and surface water locations. All but five reported concentrations are within the background range (0-33 pCi/L) and all outside this range are consistent with past results. A backlog of 27 samples to be analyzed for low-level tritium remains.

All tritium concentrations reported in this quarter are below the drinking water MCL of 20,000 pCi/L.

Strontium-90

Strontium-90 was analyzed in samples from 11 aquifer wells at or near ATR, INTEC, RWMC, TAN, and along the southern INL boundary, and four perched-groundwater wells at ATR (**Table 14**). Concentrations above the MDC were measured at three locations: TAN well TAN-10A (43 ± 10 pCi/L), INTEC well USGS-112 (6.2 ± 1.6 pCi/L), and a newly added ATR perched-groundwater well PW-12 (32.9 ± 7.9 pCi/L). Detections at TAN and INTEC are in areas of known ^{90}Sr contamination and

[3] Annual Groundwater Monitoring Status Report for Waste Area Group 2 for Fiscal Year 2019. DOE/ID-12016.

consistent with past measurements. The elevated concentration at PW-12 is consistent with the ICP contractor result of 34.0 ± 3.1 pCi/L and the cause is unknown at the present time. The results indicate that ^{90}Sr concentrations in TAN-10A and USGS-112 are continuing to decline.

Technetium-99

Technetium-99 was analyzed in samples from aquifer wells CFA-2 at CFA, USGS-112, and USGS-115 near INTEC and USGS-104 about four miles north of the southern INL boundary (**Table 15**). Low levels of ^{99}Tc were detected in just one well this quarter at USGS 115, with a ^{99}Tc concentration of 8.6 ± 4.0 pCi/L. Results from this quarter show that ^{99}Tc concentrations have decreased at USGS-115, and at USGS-104. All detections were well below the MCL of 900 pCi/L for ^{99}Tc.

Actinides

Uranium isotopes were analyzed in samples from aquifer wells TRA-07 and TRA-08 near ATR (**Table 16**). Uranium-234 and -238 were detected in both wells, and uranium-235 was detected in TRA-07 only. Uranium-234 and -238 concentrations in both wells were above the background ranges listed in **Table 10**, but the ^{234}U /^{238}U ratio does not indicate an enriched (i.e., manmade) source in either case. Concentrations of uranium isotopes in both wells were consistent with past observations.

Plutonium isotopes and ^{241}Am were analyzed in samples from aquifer wells RWMC Production and USGS-120 near RWMC (**Table 17**). Neither plutonium isotopes nor ^{241}Am were detected in either well.

Common ions, trace metals, and nutrients

Common ions (calcium, magnesium, potassium, sodium, chloride, fluoride, sulfate, alkalinity), trace metals (arsenic, barium, chromium, iron, lead, manganese, selenium, zinc), and nutrients (nitrate-plus-nitrite, phosphorous) were analyzed in samples from 21 locations (**Tables 18, 19, and 20**). All concentrations were consistent with past observations. Chromium is continuing to decline in ATR aquifer well TRA-07. Barium, iron, and manganese concentrations remain high at TAN-10A due to reducing conditions created by in situ bioremediation activities over the past several years. All common ions, trace metals, and nutrients were below their MCLs with the exception of nitrate-plus-nitrite at USGS-073 (21 mg/L). Iron and manganese at TAN-10A were well above their respective secondary MCLs.

Volatile organic compounds (VOCs)

VOCs were measured in aquifer wells RWMC Production and USGS-120 near RWMC and TAN-10A at TAN (**Table 21**). Carbon tetrachloride, trichloroethene (TCE), and chloroform continue to be detected at RWMC Production at levels consistent with previous observations. Notable MCL exceedances and/or changes from previous measurements include:

- TAN-10A cis-1,2-DCE = 3.28 µg/L, up from 2.42 µg/L in 2018, a new maximum
- TAN-10A PCE = 11.1 µg/L, up from 5.99 µg/L in 2018, a new maximum
- TAN-10A TCE = 41.6 µg/L, up from 34.4 µg/L in 2018, a new maximum
- USGS-120 Carbon tetrachloride = 3.52 µg/L, up from 2.9 µg/L in 2018, a new maximum, however this is considered a high estimate based on spiked sample results (see QA section).
- USGS-120 TCE = 1.26 µg/L, up from 1.09 µg/L in 2018, a new maximum
- USGS-120 Chloroform = 0.71 µg/L, a first detection in this location

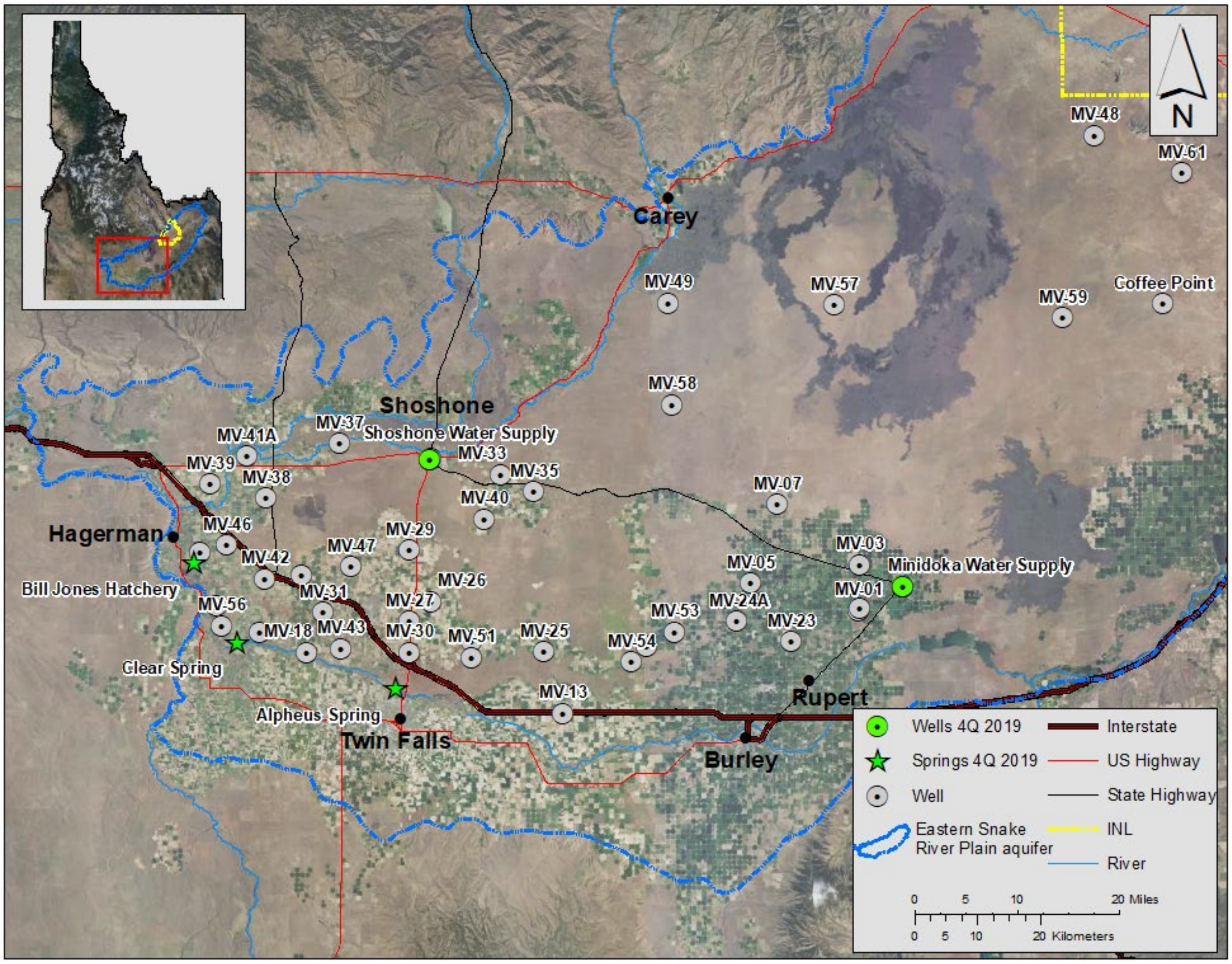

Figure 2. Distant water monitoring locations.

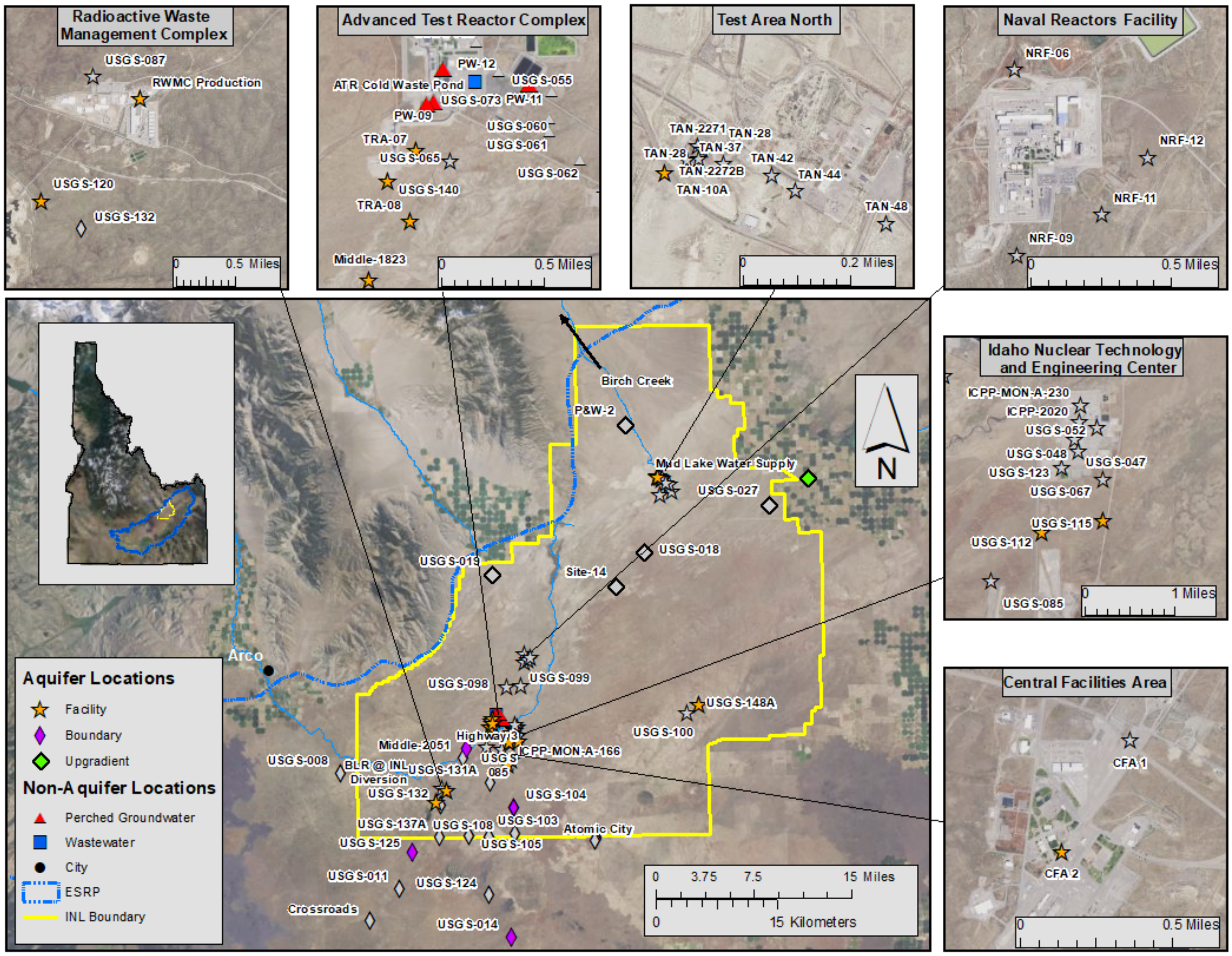

Figure 3. Up-gradient, facility, boundary, perched groundwater (GW), surface water, and wastewater monitoring locations.

Table 9. Locations sampled for water, fourth quarter, 2019.

Sample Location	Date Sampled	Co-sampler	Well Depth (ft bgs)	Analyses*
Aquifer Samples				
Upgradient				
Mud Lake Water Supply	11/4/2019	Veolia	330	α, β, γ, ^{3}H
Facility				
Advanced Test Reactor Complex:				
Middle-1823	10/14/2019	Fluor	729.7	α, β, γ, ^{3}H, ^{90}Sr, com. ions, metals, Cr, NO_3+NO_2
TRA-07	10/14/2019	Fluor	501	α, β, γ, ^{3}H, ^{90}Sr, U iso., com. ions, metals, Cr, NO_3+NO_2
TRA-08	10/14/2019	Fluor	501.5	α, β, γ, ^{3}H, ^{90}Sr, U iso., com. ions, metals, Cr, NO_3+NO_2
USGS-140	10/9/2019	USGS	546	α, β, γ, ^{3}H, ^{90}Sr, com. ions, metals, Cr, NO_3+NO_2
Idaho Nuclear Technology and Engineering Center:				
USGS-112	10/22/2019	USGS	507	α, β, γ, ^{3}H, ^{90}Sr, ^{99}Tc, com. ions, metals, Cr, Zn, NO_3+NO_2
USGS-115	10/22/2019	USGS	581	α, β, γ, ^{3}H, ^{90}Sr, ^{99}Tc, com. ions, metals, Cr, Zn, NO_3+NO_2
Radioactive Waste Management Complex:				
RWMC Production	10/15/2019	USGS	685	α, β, γ, ^{3}H, ^{90}Sr, Pu iso., ^{241}Am, com. ions, metals, Cr, NO_3+NO_2, VOCs
USGS-120	10/17/2019	USGS	705	α, β, γ, ^{3}H, ^{90}Sr, Pu iso., ^{241}Am, com. ions, metals, Cr, NO_3+NO_2, VOCs
Test Area North:				
TAN-10A	10/16/2019	Fluor	250	α, β, γ, ^{3}H, ^{90}Sr, com. ions, F, metals, Cr, As, Pb, Ba, Fe, Mn, NO_3+NO_2, P, VOCs
Central Facilities Area:				
CFA 2	10/10/2019	USGS	507	α, β, γ, ^{3}H, ^{90}Sr, ^{99}Tc, com. ions, metals, Cr, Zn, NO_3+NO_2
Materials and Fuels Complex:				
USGS-148A	11/7/2019	USGS	680	α, β, γ, ^{3}H, com. ions, F, Cr, As, Pb, Ba, Fe, Mn, Se, Zn, NO_3+NO_2, P
Boundary				
Highway 3	10/16/2019	USGS	750	α, β, γ, ^{3}H, com. ions, metals, Cr, NO_3+NO_2
USGS-014	10/17/2019	USGS	751	α, β, γ, ^{3}H, com. ions, metals, Cr, NO_3+NO_2
USGS-104	10/16/2019	USGS	700	α, β, γ, ^{3}H, ^{90}Sr, ^{99}Tc, com. ions, metals, Cr, NO_3+NO_2
USGS-125	10/17/2019	USGS	774	α, β, γ, ^{3}H, com. ions, metals, Cr, NO_3+NO_2
Distant				
Alpheus Spring	11/5/2019	Veolia	0	α, β, γ, ^{3}H
Bill Jones Hatchery	11/5/2019	Veolia	0	α, β, γ, ^{3}H
Clear Spring	11/5/2019	Veolia	0	α, β, γ, ^{3}H
Minidoka Water Supply	11/5/2019	Veolia	282	α, β, γ, ^{3}H
Shoshone Water Supply	11/5/2019	Veolia	n/a	α, β, γ, ^{3}H
Other Samples				
Perched Groundwater				
Advanced Test Reactor Complex:				
PW-9	10/9/2019	USGS	200	α, β, γ, ^{3}H, ^{90}Sr, com. ions, metals, Cr, As, NO_3+NO_2
PW-11	10/16/2019	Fluor	134.5	α, β, γ, ^{3}H, ^{90}Sr, com. ions, metals, Cr, As, NO_3+NO_2
PW-12	10/15/2019	Fluor	128	α, β, γ, ^{3}H, ^{90}Sr, com. ions, metals, Cr, As, NO_3+NO_2
USGS-073	10/9/2019	USGS	127	α, β, γ, ^{3}H, ^{90}Sr, com. ions, metals, Cr, As, NO_3+NO_2
Surface Water				
Birch Creek	10/10/2019	USGS	---	α, β, γ, ^{3}H, com. ions, metals, NO_3+NO_2
Wastewater				
ATR Cold Waste Pond	11/13/2019	BEA	---	α, β, γ, ^{3}H, com. ions, metals, NO_3+NO_2

ft bgs = feet below ground surface.
*α = gross alpha radioactivity; β = gross beta radioactivity; γ = manmade gamma-emitting radionuclides; ^{3}H = tritium; U iso. = ^{234}U, ^{235}U, ^{238}U; com. ions = Ca^{2+}, Mg^{2+}, Na^+, K^+, Cl^-, SO_4^{2-}, alkalinity; NO_3+NO_2 = nitrate plus nitrite; P = phosphorous.
n/a = well depth not available.

Table 10. Constituent background concentration ranges and EPA drinking water standards.

Constituent	Background[1]	MCL or SMCL[2]
Radiological Constituents (pCi/L)		
Gross alpha	0-5.6[a]	15
Gross beta	0-8.6[a]	4 mrem/yr
Cesium-137	0	200
Tritium	0-33[a]	20,000
Strontium-90	0	8
Technetium-99	0	900
Uranium-234	0.043-1.9[b]	30 µg/L (total U)
Uranium-235	0-0.048[b]	
Uranium-238	0.021-0.719[b]	
Plutonium-238	0	---
Plutonium-239/240	0	---
Americium-241	0	---
Non-radiological Constituents		
Common Ions (mg/L)		
Alkalinity (as $CaCO_3$)	91-261[a]	---
Calcium	23 – 71[a]	---
Chloride	4.9 – 66.6[a]	250*
Fluoride	0.1 – 1.50[a]	4
Magnesium	10.1 – 27.4[a]	---
Potassium	1.2 – 5.8[a]	---
Sodium	2.6 – 27.0[a]	---
Sulfate	9.6 – 40.4[a]	250*
Trace Metals (µg/L)		
Arsenic	2 – 3[c]	10
Barium	50 – 70[c]	2000
Chromium	<0.012 – 45[b]	100
Iron	4 – 16[d]	300*
Lead	<5[c]	15
Manganese	<1 – 4[a]	50*
Selenium	<1[c]	50
Zinc	<3 – 10.5[d]	5000*
Nutrients (mg/L)		
Nitrate plus nitrite	<0.04 – 3.59[b]	10 for NO_3^-, 1 for NO_2^-
Phosphorous	<0.01 – 0.02[d]	---
Volatile Organic Compounds (µg/L)		
Tetrachloroethene (PCE)	0	5
Trichloroethene (TCE)	0	5
1,1-Dichloroethene	0	7
cis-1,2-dichloroethene	0	70
trans-1,2-dichloroethene	0	100
Vinyl chloride	0	2
Carbon tetrachloride	0	5
Chloroform	0	80[e]
Chloromethane	0	---
Methylene Chloride	0	5
Methyl Ethyl Ketone	0	---
1,1-Dichloroethane	0	---

[1] Sources for background ranges are: [a] DEQ data compiled from distant, boundary, and surface water sites from 1993-2018;
[b] Bartholomay and Hall, 2016 (DOE/ID-22237); [c] Knobel and others, 1992; [d] Knobel and others, 1999 (DOE/ID-22164).
[2] Maximum Contaminant Levels (MCLs) are the highest levels of contaminants legally allowed in public drinking water systems in Idaho. Most wells sampled by DEQ-INL OP are not used for drinking water. A * designates a Secondary MCL (SMCL), which is a guideline recommended by the EPA for constituents that may affect the taste, color, or odor of drinking water. [e] MCL is for total trihalomethanes.

Table 11. Gross alpha, gross beta, and man-made gamma-emitting radionuclide concentrations (pCi/L) for water samples, fourth quarter, 2019.

Sample Location	Sample Date	Gross Alpha			Gross Beta			Cesium-137*		
		Concentration		2 SD	Concentration		2 SD	Concentration		2 SD
Aquifer Samples										
Upgradient										
Mud Lake Water Supply	11/4/2019	1.3		0.7	4.1		0.9	0.5	U	1.1
Facility										
Advanced Test Reactor Complex:										
Middle-1823	10/14/2019	1.7		1.0	1.5		0.9	0.2	U	1.5
TRA-07	10/14/2019	2.2		1.3	4.9		1.0	0.6	U	1.3
TRA-08	10/14/2019	2.1		1.1	4.3		0.9	0.6	U	1.4
USGS-140	10/9/2019	3.1		1.2	1.9		0.9	-0.3	U	1.5
Idaho Nuclear Technology and Engineering Center:										
USGS-112	10/22/2019	2.7		1.2	16.9		1.3	0.7	U	1.4
USGS-115	10/22/2019	1.3	U	1.1	12.3		1.2	0.8	U	1.1
Radioactive Waste Management Complex:										
RWMC Production	10/15/2019	1.0	U	1.0	2.5		0.9	0.7	U	1.2
USGS-120	10/17/2019	3.6		1.2	3.7		0.9	-0.1	U	1.2
Test Area North:										
TAN-10A	10/16/2019	5.5		1.9	134.4		3.1	-0.5	U	1.4
Central Facilities Area:										
CFA 2	10/10/2019	2.4	U	1.9	6.1		1.6	0.0	U	1.4
Materials and Fuels Complex:										
USGS-148A	11/7/2019	1.3		0.8	3.7		0.9	-0.1	U	1.4
Boundary										
Highway 3	10/16/2019	2.5		1.1	3.0		0.9	0.0	U	1.4
USGS-014	10/17/2019	3.1		1.2	3.8		1.0	0.4	U	1.7
USGS-104	10/16/2019	2.0		1.0	4.3		0.9	0.0	U	1.4
USGS-125	10/17/2019	2.4		1.0	3.2		0.8	0.1	U	1.2
Distant										
Alpheus Spring	11/5/2019	2.5		1.2	6.1		1.1	0.2	U	1.5
Bill Jones Hatchery	11/5/2019	0.8	U	0.8	3.2		0.9	0.4	U	1.2
Clear Spring	11/5/2019	1.9		1.1	5.0		1.0	0.3	U	1.5
Minidoka Water Supply	11/5/2019	2.0		1.1	4.2		1.0	0.5	U	1.4
Shoshone Water Supply	11/5/2019	1.2	U	0.9	3.4		0.9	2.1	U	1.4
Other Samples										
Perched Groundwater										
Advanced Test Reactor Complex:										
PW-9	10/9/2019	15.0		2.7	15.2		1.4	0.2	U	1.8
PW-11	10/16/2019	3.5		1.5	7.4		1.1	0.8	U	2.3
PW-12	10/15/2019	3.0		1.5	126.7		2.9	-0.7	U	1.3
USGS-073	10/9/2019	5.4		2.8	10.9		1.9	0.1	U	1.1
Surface Water										
Birch Creek	10/10/2019	2.0		1.1	1.4		0.9	1.1	U	1.2
Wastewater										
TRA Cold Waste Pond	11/13/2019	2.9	U	2.1	7.0		2.1	-1.9	U	1.6

Data qualifiers: U = undetected, J = estimate, R = rejected, “+” or “-“ after a J means that the estimated result is biased high or low, respectively.
*ISU-EML analyzes water samples for all common manmade gamma-emitting radionuclides. If none are detected, only the results for ^{137}Cs, the manmade gamma-emitter most likely to be detected in groundwater, are reported in this table.

Table 12. Tritium concentrations (pCi/L) for water samples, fourth quarter, 2019.

Sample Location	Sample Date	Tritium Concentration		2 SD
Aquifer Samples				
Upgradient				
Mud Lake Water Supply	11/4/2019	-30	U	120
Facility				
Advanced Test Reactor Complex:				
Middle-1823	10/14/2019	600		120
TRA-07	10/14/2019	3900		220
TRA-08	10/14/2019	890		130
USGS-140	10/9/2019	1060		140
Idaho Nuclear Technology and Engineering Center:				
USGS-112	10/22/2019	470		110
USGS-115	10/22/2019	980		130
Radioactive Waste Management Complex:				
RWMC Production	10/15/2019	460		110
USGS-120	10/17/2019	50	U	90
Test Area North:				
TAN-10A	10/16/2019	330		110
Central Facilities Area:				
CFA 2	10/10/2019	3000		190
Materials and Fuels Complex:				
USGS-148A	11/7/2019	80	U	120
Boundary				
Highway 3	10/16/2019	60	U	90
USGS-014	10/17/2019	20	U	90
USGS-104	10/16/2019	620		120
USGS-125	10/17/2019	70	U	90
Distant				
Alpheus Spring	11/5/2019	40	U	120
Bill Jones Hatchery	11/5/2019	-120	U	120
Clear Spring	11/5/2019	30	U	120
Minidoka Water Supply	11/5/2019	-30	U	120
Shoshone Water Supply	11/5/2019	-10	U	120
Other Samples				
Perched Groundwater				
Advanced Test Reactor Complex:				
PW-9	10/9/2019	1970		170
PW-11	10/16/2019	870		130
PW-12	10/15/2019	13390		380
USGS-073	10/9/2019	860		130
Surface Water				
Birch Creek	10/10/2019	0	U	90
Wastewater				
TRA Cold Waste Pond	11/13/2019	50	U	120

Data qualifiers: U = undetected, J = estimate, R = rejected, “+” or “-“ after a J means that the estimated result is biased high or low, respectively.

Table 13. Low-level tritium concentrations (pCi/L) in water samples collected during 2019 and analyzed using the electrolytic enrichment method, fourth quarter of 2019.

Sample Location	Sample Date	Tritium Concentration		2 SD
Aquifer Samples				
Facility				
ANP-8	6/6/2019	60		7
M15S	5/14/2019	62		9
M1S	5/13/2019	-6	U	5
NRF-06	5/15/2019	21		6
TAN-22A	6/3/2019	3	U	5
TAN-2312	6/6/2019	3	U	5
Boundary				
Atomic City	4/18/2019	6	U	7
Highway 3	10/16/2019	38		7
USGS-104	10/16/2019	662		21
USGS-124	4/18/2019	40		7
Distant				
Clear Spring	8/6/2019	8		5
Minidoka Water Supply	8/6/2019	10		6
MV-27	7/16/2019	7	U	6
MV-36	7/16/2019	16		7
MV-40	7/17/2019	4	U	5
MV-49	6/20/2019	17		6
MV-49	6/20/2019	22		8
MV-57	6/11/2019	-1	U	6
MV-58	6/20/2019	8	U	6
Surface Water				
Birch Creek	10/10/2019	16		7

Data qualifiers: U = undetected, J = estimate, R = rejected, “+” or “-“ after a J means that the estimated result is biased high or low, respectively. ft bgs = feet below ground surface.

Table 14. Strontium-90 concentrations (pCi/L) for water samples, fourth quarter, 2019.

Sample Location	Sample Date	Strontium-90		
		Concentration		2 SD
Aquifer Samples				
Facility				
Advanced Test Reactor complex:				
Middle-1823	10/14/2019	0.09	U	0.28
TRA-07	10/14/2019	0.26	U	0.37
TRA-08	10/14/2019	0.53	U	0.34
USGS-140	10/9/2019	0.42	U	0.32
Idaho Nuclear Technology and Engineering Center:				
USGS-112	10/22/2019	6.2		1.6
USGS-115	10/22/2019	0.49	U	0.46
Radioactive Waste Management Complex:				
RWMC Production	10/15/2019	-0.09	U	0.30
USGS-120	10/17/2019	-0.09	U	0.32
Test Area North:				
TAN-10A	10/16/2019	43		10
Central Facilities Area:				
CFA 2	10/10/2019	0.28	U	0.38
Boundary				
USGS-104	10/16/2019	0.17	U	0.33
Other Samples				
Perched Groundwater				
Advanced Test Reactor complex:				
PW-9	10/9/2019	0.09	U	0.39
PW-11	10/16/2019	-0.04	U	0.38
PW-12	10/15/2019	32.9		7.9
USGS-073	10/9/2019	0.69	U	0.47

Data qualifiers: U = undetected, J = estimate, R = rejected, “+” or “-“ after a J means that the estimated result is biased high or low, respectively.

Table 15. Technetium-99 concentrations (pCi/L) for water samples, fourth quarter, 2019.

Sample Location	Sample Date	Technetium-99		
		Concentration		2 SD
Aquifer Samples				
Facility				
Idaho Nuclear Technology and Engineering Center:				
USGS-112	10/22/2019	3.9	U	3.5
USGS-115	10/22/2019	8.6		4.0
Central Facilities Area:				
CFA 2	10/10/2019	1.6	U	3.1
Boundary				
USGS-104	10/16/2019	-0.3	U	3.1
Other Samples				
None				

Data qualifiers: U = undetected, J = estimate, R = rejected, “+” or “-“ after a J means that the estimated result is biased high or low, respectively.

Table 16. Uranium isotope concentrations (pCi/L) for water samples, fourth quarter, 2019.

Sample Location	Sample Date	Uranium-234			Uranium-235			Uranium-238		
		Concentration		2 SD	Concentration		2 SD	Concentration		2 SD
Aquifer Samples										
Facility										
Advanced Test Reactor complex:										
TRA-07	10/14/2019	2.14		0.44	0.053		0.048	1.14		0.27
TRA-08	10/14/2019	1.70		0.37	0.067	U	0.058	0.88		0.23
Other Samples										
None										

Data qualifiers: U = undetected, J = estimate, R = rejected, "+" or "-" after a J means that the estimated result is biased high or low, respectively.

Table 17. Plutonium isotope and americium-241 concentrations (pCi/L) for water samples, fourth quarter, 2019.

Sample Location	Sample Date	Plutonium-238			Plutonium-239/240			Americium-241		
		Concentration		2 SD	Concentration		2 SD	Concentration		2 SD
Aquifer Samples										
Facility										
Radioactive Waste Management Complex:										
RWMC Production	10/15/2019	-0.009	U	0.012	0	U	0.011	-0.002	U	0.015
USGS-120	10/17/2019	0.004	U	0.011	0.0019	U	0.0094	-0.009	U	0.014
Other Samples										
None										

Data qualifiers: U = undetected, J = estimate, R = rejected, "+" or "-" after a J means that the estimated result is biased high or low, respectively.

Table 18. Common ion concentrations (mg/L) in water samples, fourth quarter, 2019.

Sample Location	Sample Date	Calcium*		Magnesium*		Sodium*		Potassium*		Fluoride		Chloride		Sulfate		Alkalinity†	
Aquifer Samples																	
Facility																	
Advanced Test Reactor Complex:																	
Middle-1823	10/14/2019	50		17		10		1.7		-	-	11.2		32.1		171	
TRA-07	10/14/2019	81		18		16		2.8		-	-	21.4		144		137	
TRA-08	10/14/2019	51		16		9.2		2.2		-	-	11.7		45.9		157	
USGS-140	10/9/2019	50		16		11		1.8		-	-	13.7		33.9		165	
Idaho Nuclear Technology and Engineering Center:																	
USGS-112	10/22/2019	49		13		11		2.3		-	-	16.2		27.3		149	
USGS-115	10/22/2019	43		13		12		3.1		-	-	31.3		22.7		120	
Radioactive Waste Management Complex:																	
RWMC Production	10/15/2019	46		16		8.8		2.6		-	-	26.0		29.8		141	
USGS-120	10/17/2019	30		17		33		3.8		-	-	21.8		43.8		151	
Test Area North:																	
TAN-10A	10/16/2019	70		19		34		3.3		<0.2	U	80.7		32.3		197	
Central Facilities Area:																	
CFA 2	10/10/2019	80		27		34		4.6		-	-	148		49.3		137	
Materials and Fuels Complex:																	
USGS-148A	11/7/2019	36		11		16		3.1		0.658		16.3		17.2		132	
Boundary																	
Highway 3	10/16/2019	44		11		5.8		2.3		-	-	6.10		20.9		145	
USGS-014	10/17/2019	36		15		16		2.7		-	-	21.4		22.0		140	
USGS-104	10/16/2019	35		14		8.4		2.4		-	-	15.0		21.4		123	
USGS-125	10/17/2019	37		15		11		2.6		-	-	12.4		24.6		141	
Other Samples																	
Perched Groundwater																	
Advanced Test Reactor Complex:																	
PW-9	10/9/2019	63		20		20		2.6		-	-	78.8		52.8		117	
PW-11	10/15/2019	89		18		15		3.6		-	-	17.6		150		155	
PW-12	10/15/2019	72		19		17		2.4		-	-	55.3		22.7		194	
USGS-073	10/9/2019	140		30		24		3.5		-	-	172		39.7		178	
Surface Water																	
Birch Creek	10/10/2019	44		15		5.1		0.96		-	-	5.12		25.8		154	
Wastewater																	
TRA Cold Waste Pond	11/13/2019	140		50		32		4.8		-	-	38.0		444		105	

Data qualifiers: U = undetected, J = estimate, R = rejected, "<" = less than detection limit, "+" or "-" after a J means that the estimated result is biased high or low, respectively.
* Sample was filtered in the field.
† As $CaCO_3$.
"-" = not analyzed.

Table 19. Dissolved metals concentrations (µg/L) in water samples, fourth quarter, 2019.

Sample Location	Sample Date	Arsenic		Barium		Chromium		Iron		Lead		Manganese		Selenium		Zinc	
Aquifer Samples																	
Facility																	
Advanced Test Reactor Complex:																	
Middle-1823	10/14/2019	-	-	-	-	9.8		-	-	-	-	-	-	-	-	-	-
TRA-07	10/14/2019	-	-	-	-	79		-	-	-	-	-	-	-	-	-	-
TRA-08	10/14/2019	-	-	-	-	20		-	-	-	-	-	-	-	-	-	-
USGS-140	10/9/2019	-	-	-	-	16		-	-	-	-	-	-	-	-	-	-
Idaho Nuclear Technology and Engineering Center:																	
USGS-112	10/22/2019	-	-	-	-	9.7		-	-	-	-	-	-	-	-	<5.0	U
USGS-115	10/22/2019	-	-	-	-	5.2		-	-	-	-	-	-	-	-	580	
Radioactive Waste Management Complex:																	
RWMC Production	10/15/2019	-	-	-	-	11		-	-	-	-	-	-	-	-	-	-
USGS-120	10/17/2019	-	-	-	-	6.8		-	-	-	-	-	-	-	-	-	-
Test Area North:																	
TAN-10A	10/16/2019	<2.0	U	200		<1.0	U	1600		<1.0	U	570		-	-	-	-
Central Facilities Area:																	
CFA 2	10/10/2019	-	-	-	-	10		-	-	-	-	-	-	-	-	-	-
Materials and Fuels Complex:																	
USGS-148A	11/7/2019	2.0		36		1.6		<10	U	<1.0	U	<1.0	U	<2.0	U	<5.0	U
Boundary																	
Highway 3	10/16/2019	-	-	-	-	1.8		-	-	-	-	-	-	-	-	-	-
USGS-014	10/17/2019	-	-	-	-	3.5		-	-	-	-	-	-	-	-	-	-
USGS-104	10/16/2019	-	-	-	-	8.2		-	-	-	-	-	-	-	-	-	-
USGS-125	10/17/2019	-	-	-	-	4.2		-	-	-	-	-	-	-	-	-	-
Other Samples																	
Perched Groundwater																	
Advanced Test Reactor Complex:																	
PW-9	10/9/2019	<2.0	U	-	-	36		-	-	-	-	-	-	-	-	-	-
PW-11	10/15/2019	<2.0	U	-	-	15		-	-	-	-	-	-	-	-	-	-
PW-12	10/15/2019	<2.0	U	-	-	4.4		-	-	-	-	-	-	-	-	-	-
USGS-073	10/9/2019	<2.0	U	-	-	18		-	-	-	-	-	-	-	-	-	-
Wastewater																	
TRA Cold Waste Pond	11/13/2019	4.8		160		12		96		<1.0	U	3.0		3.6		-	-

Samples were filtered in the field unless otherwise noted.
Data qualifiers: U = undetected, J = estimate, R = rejected, "<" = less than detection limit, "+" or "-" after a J means that the estimated result is biased high or low, respectively.
"-" = not analyzed.

Table 20. Dissolved nutrient concentrations (mg/L) in water samples, fourth quarter, 2019.

Sample Location	Sample Date	Nitrate + Nitrite*		Total Phosphorus	
Aquifer Samples					
Facility					
Advanced Test Reactor Complex:					
Middle-1823	10/14/2019	1.0		-	-
TRA-07	10/14/2019	1.0		-	-
TRA-08	10/14/2019	1.0		-	-
USGS-140	10/9/2019	1.1		-	-
Idaho Nuclear Technology and Engineering Center:					
USGS-112	10/22/2019	1.4		-	-
USGS-115	10/22/2019	1.0		-	-
Radioactive Waste Management Complex:					
RWMC Production	10/15/2019	1.0		-	-
USGS-120	10/17/2019	0.6		-	-
Test Area North:					
TAN-10A	10/16/2019	0.39		0.049	
Central Facilities Area:					
CFA 2	10/10/2019	4.0		-	-
Materials and Fuels Complex:					
USGS-148A	11/7/2019	2.4		0.016	
Boundary					
Highway 3	10/16/2019	0.49		-	-
USGS-014	10/17/2019	1.3		-	-
USGS-104	10/16/2019	0.87		-	-
USGS-125	10/17/2019	0.64		-	-
Other Samples					
Perched Groundwater					
Advanced Test Reactor Complex:					
PW-9	10/9/2019	3.8		-	-
PW-11	10/15/2019	1.5		-	-
PW-12	10/15/2019	3.4		-	-
USGS-073	10/9/2019	21		-	-
Surface Water					
Birch Creek	10/10/2019	0.28		-	-
Wastewater					
TRA Cold Waste Pond	11/13/2019	2.7		-	-

Samples were filtered in the field unless otherwise noted.
Data qualifiers: U = undetected, J = estimate, R = rejected, "<" = less than detection limit, "+" or "-" after a J means that the estimated result is biased high or low, respectively.
* As N.
"-" = not analyzed.

Table 21. Volatile organic compound concentrations (µg/L) in water samples, fourth quarter, 2019. Only VOCs detected this quarter or in the recent past are shown.

Sample Location	Sample Date	PCE	TCE	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	Vinyl chloride	Carbon tetrachloride	Chloroform	Chloro-methane	1,1-DCA
Aquifer Samples											
Facility											
Radioactive Waste Management Complex:											
RWMC Production	10/15/2019	<0.50 U	2.88	<0.50 U	<0.50 U	<0.50 U	<0.50 U	5.78 J+	1.65	<0.50 U	<0.50 U
USGS-120	10/17/2019	<0.50 U	1.26	<0.50 U	<0.50 U	<0.50 U	<0.50 U	3.52 J+	0.71	<0.50 U	<0.50 U
Test Area North:											
TAN-10A	10/16/2019	11.1	41.6	<0.50 U	3.28	<0.50 U	<0.50 U	<0.50 U	<0.50 U	<0.50 U	<0.50 U
Other Samples											
None											

Abbreviations: PCE = tetrachloroethene; TCE = trichloroethene; 1,1-DCE = 1,1-dichloroethene; cis-1,2-DCE = cis-1,2-dichloroethene; trans-1,2-DCE = trans-1,2-dichloroethene; 1,1-DCA = 1,1-dichloroethane.
Data qualifiers: U = undetected, J = estimate, R = rejected, “<” = less than detection limit, “+” or “-“ after a J means that the estimated result is biased high or low, respectively.

Terrestrial Monitoring Results

The DEQ-INL OP conducts terrestrial (soil and milk) monitoring to characterize deposition and migration of contaminants, and provide independent verification of DOE's terrestrial monitoring programs. Physical soil sampling and *in-situ* gamma spectrometry are used to characterize actual deposition and accumulation of radioactive contaminants in soils. Milk samples are collected to evaluate the potential for ingestion of radioactivity by the population around the INL. No physical soil samples were collected during the fourth calendar quarter of 2019.

Milk

DEQ-INL OP monitors milk for the naturally occurring radionuclide potassium-40 (^{40}K) and man-made iodine-131 (^{131}I). Milk samples are collected on a monthly basis. Results for analyses of milk samples are presented in **Table 22**. ^{40}K was detected in all samples within the expected range of concentration. ^{131}I was not detected. Based on measurements of radionuclides in milk, there were no discernable impacts to the off-site environment from INL operations.

Table 22. Gamma spectroscopy analysis data for milk samples, fourth quarter, 2019.

Sample Location/Dairy	Sample Date	Naturally occurring Potassium-40		Man-made Iodine-131[1]
		Concentration[3]	± 2 SD	
Monitoring Samples				
Riverside	10/07/2019	1938	104	<MDC
Gooding/Glanbia	11/03/2019	1544	86	<MDC
	12/30/2019	1233	108	<MDC
Verification Samples[2]				
Terreton	10/01/2019	1481	86	<MDC
Dietrich	10/01/2019	1485	117	<MDC
Idaho Falls	11/05/2019	1369	113	<MDC
Minedoka	11/05/2019	1482	124	<MDC
Terreton	12/03/2019	1366	117	<MDC
Dietrich	12/03/2019	1513	86	<MDC

[1] <MDC – Less than Minimum Detectable Concentration (approximately 4 pCi/L for iodine-131).
[2] DEQ-INL OP samples collected by the off-site INL environmental surveillance contractor.
[3] Concentrations with associated uncertainties (±2 SD) are expressed in pCi/L.

Soil

DEQ-INL OP monitors long-term radiological conditions via physical soil sampling as well as field instrumentation capable of identifying and measuring *in-situ* concentrations of gamma-emitting radionuclides in soil. Monitoring concentrations of gamma-emitting radionuclides in surface soil provides some insight to transport, deposition, and accumulation of radioactive material in the environment as a result of INL operations as well as historical above ground testing of nuclear weapons.

In-Situ gamma spectroscopic measurements were performed at 24 locations (see **Figure 4**) during the fourth calendar quarter of 2019. ^{137}Cs was the only man made gamma emitting radionuclide detected. Analysis results for ^{137}Cs concentrations for *in-situ* soil monitoring are shown in **Table 23**.

Table 23. *In-Situ* gamma spectroscopic analysis results (^{137}Cs) for soil, fourth quarter, 2019.

Location	Date Acquired	Concentration[1]	±2 SD	MDA
Boundary Sampling Locations				
Big Southern Butte	11/19/2019	0.162	0.026	0.008
Large Grid 18-4	11/19/2019	0.164	0.030	0.010
Reno Ranch ESER Soil Site	11/21/2019	0.229	0.024	0.008
Howe Met Tower	11/21/2019	0.115	0.022	0.009
Atomic City Air Station	11/18/2019	0.149	0.029	0.008
Monteview ESER Soil Site	11/15/2019	0.167	0.024	0.008
Monteview Air Station	11/15/2019	0.072	0.020	0.008
Mud Lake Air Station	11/15/2019	0.028	0.020	0.008
Distant Sampling Locations				
Sage Junction	11/21/2019	0.172	0.026	0.011
St. Anthony ESER Soil Site	11/13/2019	0.195	0.028	0.010
Idaho Falls CMS[3]	11/13/2019	0.041	0.016	0.006
Idaho Falls Air Station[2]	11/13/2019	0.049	0.022	0.008
Blackfoot ESER Soil Site	11/18/2019	0.117	0.030	0.007
Roberts Met. Tower	11/21/2019	0.121	0.024	0.010
On Site Sampling Locations				
Large Grid 18-8	11/25/2019	0.181	0.025	0.008
Large Grid 24-7	11/25/2019	0.113	0.029	0.010
Rover	11/25/2019	0.134	0.034	0.010
Large Grid 18-1	11/25/2019	0.146	0.029	0.010
Large Grid 30-1	11/21/2019	0.186	0.024	0.009
Van Buren Air Station	11/26/2019	0.251	0.030	0.010
Big Lost River Rest Area	11/21/2019	0.066	0.022	0.010
INL Main Gate	11/18/2019	0.160	0.030	0.011
Experimental Field Station	11/19/2019	0.226	0.030	0.010
EFS[4] Sheep Fire area	11/19/2019	0.318	0.0340	0.010

[1]Concentrations, 2 SD, and MDA are reported in pCi/g.
[2]DEQ-INL OP HPIC air monitoring station near Idaho Falls, ID.
[3]DEQ-INL OP HPIC Community Monitoring Station (CMS) near John's Hole Bridge Idaho Falls, ID.
[4]EFS = Experimental Field Station.

The average Cesium-137 value was 0.15 picocuries per gram (pCi/g) with a minimum value of 0.03 pCi/g and a maximum of 0.32 pCi/g, well below the DEQ-INL OP action level of 6.4 pCi/g and the recommended federal screening limit for surface soil of 6.8 pCi/g (NCRP Report 129).

Based upon terrestrial radiological measurements of soil and milk, there were no discernable impacts to the off-site environment from INL operations. Long-term accumulation of radionuclides observed by soil monitoring was consistent with historical measurements and was in the range of concentrations expected as a result of historic above-ground testing of nuclear weapons.

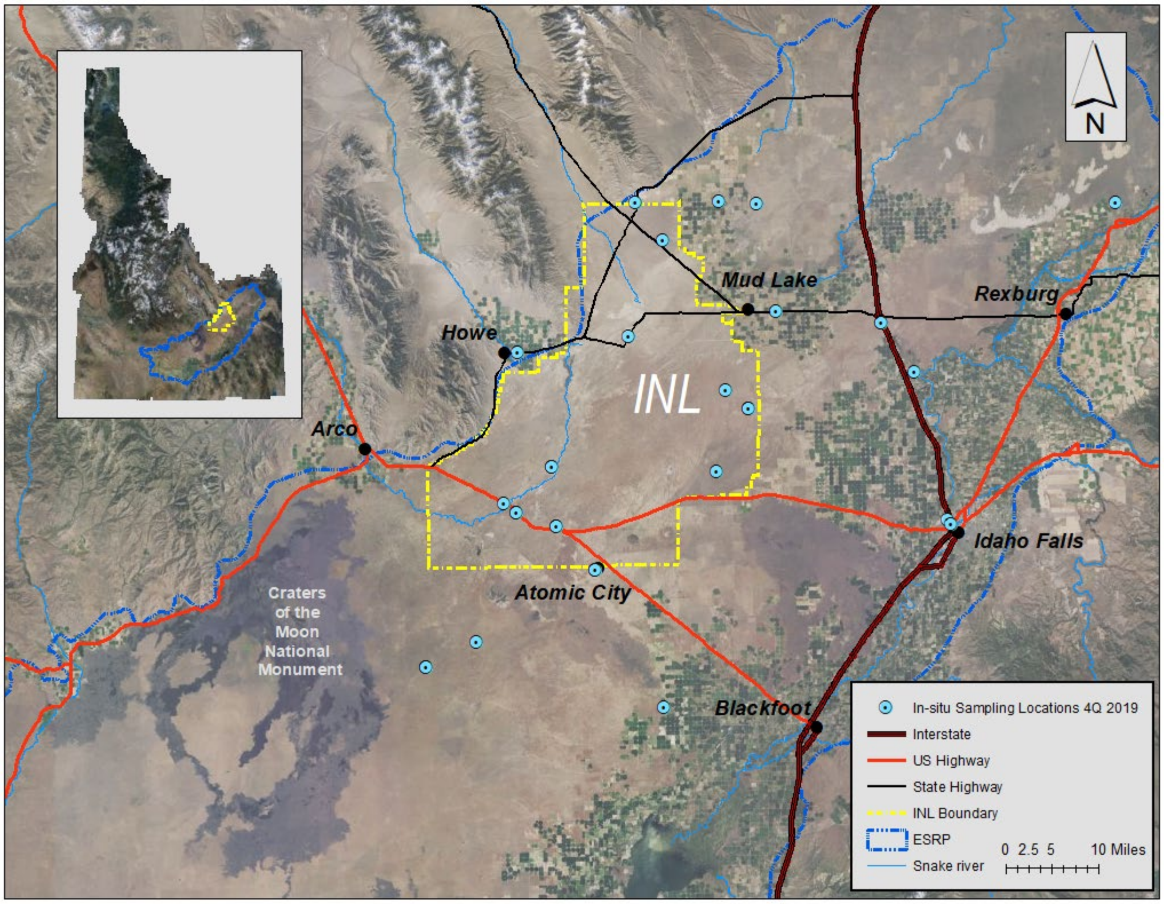

Figure 4. *In-situ* soil monitoring sites. Experimental Field Station and EFS Sheep Fire Area appear as one location on the map due to their close proximity to each other, fourth quarter 2019.

Quality Assurance

Measurements of constituent concentrations in environmental media are subject to inaccuracy from errors that may be introduced during the collection, transportation, and analysis of samples, calibration of equipment, and recording and reporting of results. While it is impossible to quantify every error that may affect a result, a quality assurance (QA) program can evaluate the overall quality of a dataset and, in many cases, identify and address errors or inaccuracies. DEQ-INL OP's QA program is designed to (1) ensure sample integrity, (2) evaluate the precision and accuracy of analytical results, and (3) ensure that the environmental data are representative and complete.

This section summarizes the quality assurance assessment of the data collected by DEQ-INL OP in the fourth quarter of 2019. Included are the results of quality control (QC) samples (blanks, duplicates, and spikes) that DEQ-INL OP submitted to Idaho State University's Environmental Monitoring Laboratory (ISU-EML) for radiological analyses and to the Idaho Bureau of Laboratories-Boise (IBL) for non-radiological analyses during the quarter. The analytical results of QC samples are used to assess the precision, accuracy, and representativeness of the environmental data presented in this report. During the fourth quarter of 2019, DEQ-INL OP submitted 82 QC samples for various radiological and non-radiological analyses (**Table 24**).

All samples referenced in this report were collected in accordance with written procedures maintained by the DEQ-INL OP. Analytical methods and QC procedures used by the laboratories were performed in accordance with approved written procedures maintained by each lab. QC samples analyzed by the labs as part of each lab's internal QA program are not discussed in this report.

Blank Samples

Blank samples consist of matrices that contain immeasurable or acceptably low concentrations of the analyte(s) of interest. They are used to monitor for contamination introduced during sample collection, storage, shipment, and analysis. For water matrices, a blank sample consists of 18-megaohm deionized water from the DEQ-Idaho Falls Regional office and is categorized as a field blank, equipment blank, or trip blank depending on how the blank is handled. A field blank is used to monitor for contamination introduced from the environment during sample collection, an equipment blank is used to monitor for contamination introduced by contaminated equipment, and a trip blank is used to monitor for contamination introduced during transportation of samples (trip blanks are typically only used for VOCs). Most water blank samples submitted to laboratories by DEQ-INL OP are field blanks.

For all analyses except low-level tritium in water, a blank sample result is considered acceptable if it is less than or equal to the minimum detectable concentration (MDC). For low-level tritium analyses in water samples, a blank sample result is acceptable if it is less than or equal to 33 pCi/L.[3] If a blank result exceeds acceptance criteria, above-MDC results in other samples collected, transported, or analyzed together with the failed blank may be qualified as biased high (J+) or rejected (R), or may remain unqualified, depending on the relative sizes of the blank detection and other sample results.

Blank sample results submitted for gross alpha and gross beta screening in air for the fourth quarter of 2019 are presented in **Table 25**. Blank sample results for select gamma emitters in air from composited air filters are presented in **Table 26**. Data for blank analyses used to assess data quality for tritium in water vapor in air are presented in **Table 27**. Blank sample results for radiological and non-radiological analytes in ground and surface water are presented in **Tables 28-30**.

All blank sample results passed acceptance criteria in the fourth quarter of 2019.

Duplicate Samples

A duplicate sample is one that is collected at the same location and approximately the same time as another sample (referred to as the "original" sample). Duplicate sample results are compared to the original sample's results to evaluate reproducibility. Significant differences between the two could indicate poor analytical precision or a non-uniform sample matrix.

The difference between the results of an original and duplicate sample (referred to below as a "duplicate-sample pair") is evaluated differently for radiological and non-radiological analyses. For radiological analyses, the results of a duplicate-sample pair are considered to be in agreement if their absolute difference is less than or equal to three times the pooled error of the results:

$$|R_1 - R_2| \leq 3\sqrt{S_1^2 + S_2^2}$$

R_1 = Original sample result
R_2 = Duplicate sample result

[3] The water used by DEQ-INL OP to create blank samples contains measureable concentrations of tritium produced cosmogenically and by above-ground testing of nuclear weapons during the twentieth century. The highest tritium concentration that DEQ considers acceptable in a blank is calculated as the mean tritium concentration in DEQ blanks from 2013 to 2017 plus two standard deviations.

S_1 = Analytical uncertainty (1 SD) of the original result
S_2 = Analytical uncertainty (1 SD) of the duplicate result

Radiological results are also considered to be in agreement if their relative percent difference (RPD) is no more than ±20 percent. RPD is calculated as:

$$RPD = \frac{R_1 - R_2}{(R_1 + R_2)/2} \times 100$$

For non-radiological analyses, the RPD is used to evaluate duplicate sample pairs in which both results exceed five times the MDC. An RPD of up to ±20 percent is acceptable. If one or both of the sample results is less than five times the MDC, the results are in agreement if their absolute difference is less than or equal to the MDC.

Duplicate results for radiological analyses in groundwater and surface water are presented in **Table 31-33**. Duplicate results for *in-situ* soil analyses are presented in Table 35. All duplicate results passed acceptance criteria in the fourth quarter of 2019.

Spiked Samples

Spiked samples are samples to which known concentrations of specific analytes have been added. They are used to assess a laboratory's analytical accuracy. The percent recovery (%R) of each spiked-sample analysis is calculated as the ratio of the spike concentration determined by the lab to the known spike concentration. DEQ-INL OP considers the lab's result to be in control if the percent recovery is 100 ± 25%. If the percent recovery of a spiked sample is 50-74%, above-MDC results of samples analyzed in the same batch as the spiked sample may be qualified as low-biased estimates (J-), and below-MDC results may be qualified as undetected estimates (UJ). If the percent recovery of a spiked sample is 126-150%, above-MDC results of associated samples may be qualified as high-biased estimates (J+), and below-MDC results may be qualified as undetected (U). If the percent recovery of a spiked sample is <50% or >150%, the results of all associated samples may be qualified as rejected (R), except for sample results below MDC associated with a spiked-sample analysis having a percent recovery >150%, in which case the sample result remains qualified as undetected (U).

Two spiked water samples (191W674, 191W679) were analyzed for radiological constituents (**Table 34**). Four spiked water samples were analyzed for common ions (191W576), trace metals (191W577), nutrients (191W578), and VOCs (191W579) (**Tables 35-38)**. Most analyses were determined to have passed criteria (%R within 100±25%) but two analytes were outside the acceptable range. These include one carbon tetrachloride, and one vinyl chloride. As a result, the associated field samples analyzed for VOCs on that same day have been qualified as described above. This resulted in two VOC results being qualified as high estimates (J+) for this quarter. All others were in the acceptable range and no other data were qualified.

DEQ-INL OP also prepares additional "spike-like" quality control samples to assess ambient radiation measurement bias. Once per quarter, DEQ-INL OP irradiates a number of electret ionization chambers (EICs) to verify EIC response. Irradiations of EICs are conducted in a repeatable geometry to a known exposure of near 30 mR and two additional higher and lower exposures, ranging from 15 to 60 mR. EIC responses are compared directly with the exposure received from the NIST traceable cesium-137 source provided by ISU-EML. EIC response is considered acceptable if each measurement has a percent recovery of 100 ± 25% when compared to the known irradiated quantity. The irradiation results for fourth quarter 2019 are presented in **Table39**. Real-time pressure correction is used to calculate the net exposure measured by these EIC control sets. All EIC spiked samples passed the DEQ-INL OP criteria.

Laboratory QC Issues

There were no laboratory QC issues to report in the fourth quarter of 2019.

Analytical QA/QC Assessment

No issues involving sample chain of custody, sample holding times, and the analysis of blank, duplicate, and spiked samples were observed during the fourth quarter of 2019 which significantly affected data quality. Methodologies and data reports issued by the contracting laboratories generally conformed to the requirements of DEQ-INL OP during the fourth quarter of 2019.

Data usability is the measure of field sample results that are not rejected divided by the total number of field sample results obtained. The overall data usability of 99.1% for the fourth quarter of 2019 is well above the acceptable value of 90% for the DEQ-INL OP ESP and is summarized in **Table 24**. The overall data completeness (usable results divided by the total number of field sample results expected) of 98.4 % is also acceptable.

Preventative Maintenance and Equipment Reliability

All equipment was calibrated and checked according to prescribed periodicity. During the fourth quarter of 2019 the TSP sampler at the Experimental Field Station was replaced. The TSP sampler at Howe was inoperable for the last two weeks of the quarter. Service reliability for air sampling equipment for the fourth quarter of 2019 is summarized in **Table 40**.

Conclusion

All data collected for the fourth quarter of 2019 have been assigned the applicable qualifiers to designate the appropriate use of the data. The overall data usability of 99.1% and data completeness of 98.4% are acceptable for the quarter, with the data meeting the requirements and data quality objectives established by DEQ-INL OP.

Table 24. Summary of the analyses performed in the fourth quarter, 2019.

Media Sampled	Collection Device	Analyte	Sample Analyses	Blank Analyses	Duplicate Analyses	Spike Analyses	Data Rejected[1]	Analyzing Lab[2]
Air								
Particulate	4-inch filter	Gross alpha	152	13	0	0	3	ISU-EML
		Gross beta	152	13	0	0	3	ISU-EML
		Gamma emitters	11	1	0	0	0	ISU-EML
		Radiochemical	0	0	0	0	0	ISU Sub
Water Vapor	Desiccant column	Tritium	21	5	0	0	0	ISU-EML
Gaseous	Charcoal filter	Iodine-131	14	0	0	0	0	ISU-EML
Precipitation	Poly bottle	Tritium	6	0	0	0	0	ISU-EML
		Gamma emitters	6	0	0	0	0	ISU-EML
Water								
Groundwater & Surface Water	Grab or composite	Gross alpha	28	2	1	0	0	ISU-EML
		Gross beta	28	2	1	0	0	ISU-EML
		Gamma emitters	28	2	1	5	0	ISU-EML
		Tritium	28	2	1	1	0	ISU-EML
		Low-level tritium	20	4	1	0	0	ISU-EML
		Radiochemical	26	0	2	0	0	ISU Sub
		Metals	21	1	1	1	0	IBL
		Common Ions	21	1	1	1	0	IBL
		Nutrients	21	1	1	1	0	IBL
		Volatile Organics	3	0	0	1	0	IBL
Terrestrial								
Milk	Grab or composite	Gamma emitters	9	0	0	0	0	ISU-EML
Soil	*in situ*	Gamma emitters	24	0	6	0	0	DEQ-INL OP
	Grab – "puck"	Gamma emitters	0	0	0	0	0	ISU-EML
Radiation								
Ambient	EICs	Gamma Radiation	67	0	0	9	0	DEQ-INL OP
	HPICs	Gamma Radiation	8	NA	NA	NA	0	DEQ-INL OP
Total analyses performed			**694**	**47**	**16**	**19**	**6**	
Total QC analyses performed (blanks, duplicates, and spikes)			**82**					
Ratio of total QC analyses to total sample analyses[3]			**11.8%**					
Percentage of data that are useable[4]			**99.1%**					

[1] Combined Laboratory and DEQ-INL OP rejection criteria (data was rejected for any reason).

[2] ISU-EML = Idaho State University – Environmental Monitoring Laboratory; ISU Sub = Subcontract laboratory to ISU-EML; IBL = Idaho Bureau of Laboratories, Boise; IBL Sub = Subcontract laboratory to IBL; DEQ-INL OP = Analyzed by INL Oversight Program, Idaho Department of Environmental Quality.

[3] DEQ-INL OP requires that the number of QC analyses performed be at least 10 percent of the number of sample analyses performed.

[4] Data usability is calculated as [total analyses – rejected data]/[total analyses]. DEQ-INL OP considers a data usability rate of 90 percent or higher to be acceptable.

Table 25. Blank analysis results for gross alpha and beta (TSP), fourth quarter, 2019.

Collection Period		Corrected volume (m^3)[1]	Gross alpha			Gross beta		
Start	Stop		Value	Uncertainty (± 2 SD)	MDC	Value	Uncertainty (± 2 SD)	MDC
09/26/19	10/03/19	2075	0.1	0.1	0.2	0.0	0.5	0.8
10/03/19	10/10/19	2075	0.1	0.1	0.2	0.1	0.5	0.8
10/10/19	10/17/19	2075	0.0	0.1	0.3	0.0	0.5	0.8
10/17/19	10/24/19	2075	-0.1	0.1	0.3	0.0	0.5	0.8
10/24/19	10/31/19	2075	-0.1	0.1	0.3	-0.3	0.4	0.8
10/31/19	11/07/19	2075	0.0	0.1	0.3	-0.3	0.5	0.8
11/07/19	11/14/19	2075	0.0	0.1	0.3	-0.1	0.5	0.8
11/14/19	11/21/19	2075	0.2	0.1	0.2	0.3	0.5	0.8
11/21/19	11/27/19	2075	0.0	0.1	0.3	0.0	0.5	0.8
11/27/19	12/04/19	2075	0.2	0.2	0.2	-0.6	0.5	0.8
12/04/19	12/10/19	2075	-0.1	0.2	0.3	0.0	0.4	0.8
12/10/19	12/19/19	2075	0.1	0.1	0.2	-0.1	0.5	0.8
12/19/19	12/26/19	2075	0.2	0.2	0.3	0.1	0.5	0.8
12/26/19	01/02/20	2075	0.0	0.1	0.2	0.0	0.5	0.8

Note: Concentrations values, associated uncertainties (± 2 SD) and minimum detectable concentrations (MDC) are expressed in 1 x 10^{-3} pCi/m^3.
[1]A volume equal to the average of the volumes collected through each valid field filter was used to compute "concentrations" for the blank for meaningful comparison to sample results. No air was passed through the blank filters.

Table 26. Blank analysis results for gamma spectroscopy for TSP air filters, composite samples, fourth quarter, 2019.

Analysis Date	Beryllium-7			Ruthenium-106/Rhodium-106			Antimony-125		
	Concentration[1]	± 2 SD	MDC	Concentration	± 2 SD	MDC	Concentration	± 2 SD	MDC
01/17/2020	20	31	51	-14	51	88	4	8	13

Analysis Date	Cesium-134			Cesium-137		
	Concentration[1]	± 2 SD	MDC	Concentration	± 2 SD	MDC
10/12/2019	-5	4	6	2	4	6

Note: Concentrations are expressed in 1 x 10^{-5}pCi/m^3 with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).
[1] These concentrations are from blank filters collected weekly, composited, and analyzed for the calendar quarter. A composite volume equal to the sum of the weekly average volumes collected through each valid field filter was used to compute "air concentrations" for the blank for meaningful comparison to sample results. No air was actually passed through the blank filters.

Table 27. Blank analysis results for tritium in water vapor from air samples, fourth quarter, 2019.

Sample Number	Start Date	Collection Date	Analysis Date	Tritium		
				Concentration	± 2 SD	MDC
OP194ZTR01	01/30/20	01/30/20	02/06/20	0.13	0.09	0.15
OP194ZTR02	01/30/20	01/30/20	02/06/20	0.13	0.09	0.15
OP194ZTR03	01/30/20	01/30/20	02/06/20	0.08	0.09	0.15
OP194Sink	01/27/20	02/03/20	02/06/20	0.06	0.09	0.15
OP194Fridge	01/27/20	02/03/20	02/06/20	0.00	0.08	0.15

Note: Concentrations are expressed in nCi/L with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).

Table 28. Blank analysis results (pCi/L) for radiological constituents in water, fourth quarter, 2019.

Sample Number	Sample Date	Blank Type	Concentration	± 2 SD	MDC	Within Blank Criteria?
Gross Alpha						
191W580	10/22/2019	Field	0.0	0.2	0.4	Yes
191W740	11/5/2019	Field	0.0	0.3	0.4	Yes
Gross Beta						
191W580	10/22/2019	Field	0.3	0.6	0.9	Yes
191W740	11/5/2019	Field	-0.3	0.6	1.1	Yes
Cesium-137						
191W580	10/22/2019	Field	0.0	1.2	2.5	Yes
191W740	11/5/2019	Field	1.8	1.5	3.2	Yes
Tritium (standard method)						
191W581	10/22/2019	Field	60	90	150	Yes
191W741	11/5/2019	Field	-100	120	200	Yes
Tritium (low-level method)						
191W540	8/6/2019	Field	20	7	10	Yes*
191W068	4/16/2019	Field	19	7	11	Yes*
191W581	10/22/2019	Field	26	8	11	Yes*
191W410	6/24/2019	Field	19	7	11	Yes*

MDC = minimum detectable concentration.
*Detections in this range are typical of the deionized water used by DEQ to prepare blank samples.

Table 29. Blank analysis results (µg/L) for metals in groundwater and/or surface water, fourth quarter, 2019.

Sample Number	Sample Date	Blank Type	Arsenic	Barium	Chromium	Iron	Lead	Manganese	Selenium	Zinc
191W583	10/22/2019	Field	<2.0	<1.0	<1.0	<10	<1.0	<1.0	<2.0	<5.0

Table 30. Blank analysis results (mg/L) for common ions and nutrients in groundwater and/or surface water, fourth quarter, 2019.

Sample Number	Sample Date	Blank Type	Calcium	Magnesium	Sodium	Potassium	Fluoride	Chloride	Sulfate	Alkalinity†	NO_3+NO_2*	Total Phosphorus
191W583,582	10/22/2019	Field	<0.1	<0.1	<0.1	<0.1	<0.2	<0.4	<0.8	<1	<0.01	<0.005

† As $CaCO_3$.

* As N.

Table 31. Duplicate sample results (pCi/L) for radiological constituents in groundwater and/or surface water, fourth quarter, 2019.

Analysis/Sample Location	Original Sample Number	Concentration	± 2 SD	Duplicate Sample Number	Concentration	± 2 SD	RPD	$\lvert R_1-R_2 \rvert$	$3(S_1^2+S_2^2)^{1/2}$	Within Criteria?
Gross Alpha										
CFA 2	191W590	2.4	1.9	191W667	1.9	1.4	23	0.5	3.5	Yes
Gross Beta										
CFA 2	191W590	6.1	1.6	191W667	6.5	1.5	-6	0.4	3.3	Yes
Cesium-137										
CFA 2	191W590	0.0	1.4	191W667	1.0	1.3	-200	1.0	2.9	Yes
Tritium (standard method)										
CFA 2	191W593	3000	190	191W670	2950	190	2	50	403	Yes
Tritium (low-level method)										
MV-49*	191W395	17	6	191W400	22	8	-26	5	15	Yes
Strontium-90										
CFA 2	191W591	0.28	0.38	191W668	0.03	0.27	161	0.3	0.7	Yes
Technetium-99										
CFA 2	191W592	1.6	3.1	191W669	0.10	3.2	176	1.5	7	Yes

*Location sampled in second quarter 2019

RPD = relative percent difference.

Table 32. Duplicate results for metals (µg/L) in groundwater, fourth quarter, 2019.

Sample Location	Sample Number	Sample Date	Arsenic	Barium	Chromium	Iron	Lead	Manganese	Selenium	Zinc
CFA 2	191W595	10/10/2019	-	-	10	-	-	-	-	-
CFA 2	191W672	10/10/2019	-	-	10	-	-	-	-	-
RPD			-	-	0.0	-	-	-	-	-

RPD = relative percent difference

Table 33. Duplicate sample results for common ions and nutrients (mg/L) in groundwater, fourth quarter, 2019.

Sample Location	Sample Number	Sample Date	Calcium	Magnesium	Sodium	Potassium	Fluoride	Chloride	Sulfate	Total Alkalinity†	Total Nitrogen	Total Phosphorus
CFA 2	191W595,594	10/10/2019	80	27	34	4.6	-	148	49.3	137	4	-
CFA 2	191W672,671	10/10/2019	81	27	34	4.5	-	148	49.3	139	4	-
RPD			-1	0	0	2	-	0	0	-1	0	-

RPD = relative percent difference.

† As $CaCO_3$.

Table 34. Duplicate *in-situ* analyses of gamma emitting radionuclides in soil, fourth quarter, 2019.

Sample Location	Sample Date	Original Result K-40 (pCi/g)[1]	Duplicate Result K-40 (pCi/g)[1]	K-40 RPD (%)	K-40 Less than 3 sigma test	K-40 Meets either criterion?	Original Result Cs-137 (pCi/g)[1]	Duplicate Result Cs-137 (pCi/g)[1]	Cs-137 RPD (%)	Cs-137 Less than 3 sigma test	Cs-137 Meets either criterion?
Large Grid 24-7	11/25/2019	20.0 ± 0.8	20.1 ± 0.8	-0.5	In Spec	Yes	0.113 ± 0.029	0.0939 ± 0.029	18.5	In Spec	Yes
Atomic City Air Station	11/18/2019	17.8 ± 0.8	17.3 ± 0.8	2.8	In Spec	Yes	0.126 ± 0.027	0.149 ± 0.029	-16.7	In Spec	Yes
Big Southern Butte	11/19/2019	18.2 ± 0.8	18.2 ± 0.8	0.0	In Spec	Yes	0.156 ± 0.023	0.162 ± 0.026	-3.8	In Spec	Yes
INL Main Gate	11/18/2019	18.1 ± 0.8	18.4 ± 0.8	-1.6	In Spec	Yes	0.157 ± 0.030	0.160 ± 0.030	-1.9	In Spec	Yes
Sage Junction	11/21/2019	21.8 ± 0.9	21.0 ± 0.8	3.7	In Spec	Yes	0.172 ± 0.026	0.171 ± 0.027	0.6	In Spec	Yes
Van Buren	11/26/2019	19.3 ± 0.8	20.8 ± 0.9	-7.5	In Spec	Yes	0.199 ± 0.031	0.251 ± 0.030	-23.1	In Spec	Yes

[1]Result ±2 SD

Table 35. Spiked sample results for radiological constituents in water, fourth quarter, 2019.

Sample Number	Sample Date	Spike (RESL)	Result (ISU-EML)	%R
Cesium-137				
191W674	10/8/2019	2.0	2.4	120
Tritium				
191W679	10/8/2019	6800	6780	100
Manganese-54*				
191W674	10/8/2019	141.0	143.2	102
Cobalt-57*				
191W674	10/8/2019	140.0	142.4	102
Cobalt-60*				
191W674	10/8/2019	165.0	164.7	100
Cs-134*				
191W674	10/8/2019	115.0	115.8	101

*Additional analyses reported by ISU-EML but not requested or included in DEQ analytical result tables.

Table 36. Spiked sample results (µg/L) for metals in water, fourth quarter, 2019.

Sample Number	Sample Date	Barium			Chromium			Lead			Manganese			Zinc		
		Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R
191W577	10/10/2019	125	130	104	105	100	95	7.23	7.40	102	8.85	9.50	107	80.8	81.0	100

Table 37. Spiked sample results (mg/L) for common ions and nutrients in water, fourth quarter, 2019.

Sample Number	Sample Date	Calcium			Magnesium			Sodium			Potassium			Fluoride		
		Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R
191W576	10/10/2019	15.9	15.0	94	15.1	14.0	93	16	15	94	5.8	5.6	97	0.636	0.506	80

Table 37. (Continued). Spiked sample results (mg/L) for common ions and nutrients in water, fourth quarter, 2019.

Sample Number	Sample Date	Chloride			Sulfate			Total Alkalinity as $CaCO_3$			Total Nitrogen			Total Phosphorus		
		Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R
191W5576, 578	10/10/2019	95.3	92.5	97	18.6	18.1	97	80.2	77.5	97	3.01	3.00	100	0.0204	0.0190	93

Table 38. Spiked sample results (µg/L) for VOCs in water, fourth quarter, 2019.

Sample Number	Sample Date	Carbon Tetrachloride			Styrene			Tetrachloroethene			Trichloroethene			Vinyl Chloride		
		Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R
191W579	10/10/2019	8.92	11.5	129	15.1	11.7	77	12.3	13.4	109	8.30	9.31	112	8.80	11.4	130

Table 39. Electret ionization chamber (EIC) irradiation results (categorized as spiked samples), fourth quarter, 2019.

Electret #	Exposure Received		Net Measured Exposure[1]		%R	Within Spec?
	(mR)	Uncertainty (±1 SD, mR)	(mR)	Uncertainty (±1 SD, mR)		
SJE113	40.0	2.0	36.4	1.4	91.1%	Y
SKR291	40.0	2.0	33.7	1.4	84.4%	Y
SJE131	40.0	2.0	36.1	1.3	90.1%	Y
				Triplicate AVG:	**88.5%**	**Y**
SKR353	30.0	1.5	26.0	1.4	86.8%	Y
SJE044	30.0	1.5	26.6	1.3	88.8%	Y
SKR401	30.0	1.5	26.4	1.4	88.1%	Y
				Triplicate AVG:	**87.9%**	**Y**
SKR319	20.3	1.0	16.6	1.4	81.6%	Y
SKR267	20.3	1.0	15.9	1.4	78.3%	Y
SJE220	20.3	1.0	20.4	1.3	100.3%	Y
				Triplicate AVG:	**86.8%**	**Y**

Note: A percent recovery (%R) of 100 ± 25 is considered acceptable.
[1] Net measured exposure estimate includes a correction for atmospheric pressure.

Table 40. Air sampling field equipment service reliability (percent operational), fourth quarter, 2019.

Station Locations	Sample Type			
	TSP	Radioiodine	Atmospheric Moisture	Precipitation
Onsite Locations				
Big Lost River Rest Area	100%	100%	100%	100%
Experimental Field Station	92%	100%	100%	NC[1]
Sand Dunes Tower	100%	100%	100%	NC[1]
Van Buren Avenue	100%	100%	100%	NC[1]
Boundary Locations				
Atomic City	100%	100%	100%	100%
Howe	86%	100%	100%	100%
Monteview	100%	100%	100%	100%
Mud Lake	100%	100%	100%	100%
Distant Locations				
Craters of the Moon	100%	100%	100%	NC[1]
Idaho Falls	100%	100%	100%	100%

Note: The values in this table were calculated by dividing the number of weeks the equipment was in operation by the number of weeks in the quarter.

[1] NC = Sample not collected at this location.

Appendix A

Table A-1. Weekly concentrations (in 1 x 10^{-3} pCi/m^3) for gross alpha and gross beta analyses for TSP filters for all locations, fourth quarter, 2019.

Sample Location	Collection Date		Gross Alpha		Gross Beta	
	Start	Stop	Concentration	±2 SD	Concentration	±2 SD
On-Site Locations						
Big Lost River Rest Area	09/26/19	10/03/19	0.8	0.2	25.8	1.0
	10/03/19	10/10/19	0.5	0.2	28.4	1.0
	10/10/19	10/17/19	1.1	0.2	51.5	1.4
	10/17/19	10/24/19	0.5	0.2	21.6	0.9
	10/24/19	10/31/19	0.8	0.2	25.9	1.0
	10/31/19	11/07/19	1.2	0.2	64.8	1.5
	11/07/19	11/14/19	1.3	0.2	49.0	1.3
	11/14/19	11/21/19	1.1	0.2	39.9	1.2
	11/21/19	11/27/19	0.8	0.2	39.7	1.3
	11/27/19	12/04/19	0.6	0.2	40.7	1.2
	12/04/19	12/10/19	0.5	0.2	32.8	1.2
	12/10/19	12/19/19	0.6	0.1	28.6	0.9
	12/19/19	12/26/19	0.6	0.2	46.9	1.3
	12/26/19	01/02/20	0.9	0.2	57.8	1.4
Experimental Field Station	09/26/19	10/03/19	0.9	0.2	24.4	1.1
	10/03/19	10/10/19	1.6	0.3	25.2	1.2
	10/10/19	10/17/19	1.5	0.3	46.2	1.5
	10/17/19	10/24/19	1.2	0.3	18.0	1.0
	10/24/19	10/31/19	2.1	0.3	24.1	1.2
	10/31/19	11/07/19	1.2	0.3	54.6	1.6
	11/07/19	11/14/19	NS[1]	NS[1]	NS[1]	NS[1]
	11/19/19	11/21/19	R[2]	R[2]	R[2]	R[2]
	11/21/19	11/27/19	0.8	0.3	51.4	1.7
	11/27/19	12/04/19	1.0	0.2	47.7	1.5
	12/04/19	12/10/19	1.0	0.3	49.4	1.6
	12/10/19	12/19/19	1.4	0.2	84.6	1.7
	12/19/19	12/26/19	2.4	0.4	142.6	2.5
	12/26/19	01/02/20	2.4	0.3	167.8	2.7
Sand Dunes Tower	09/26/19	10/03/19	0.4	0.2	15.9	0.9
	10/03/19	10/10/19	0.6	0.2	18.4	0.9
	10/10/19	10/17/19	1.0	0.2	34.9	1.3
	10/17/19	10/24/19	0.3	0.2	14.3	0.9
	10/24/19	10/31/19	0.5	0.2	19.5	1.0
	10/31/19	11/07/19	1.1	0.2	44.7	1.4
	11/07/19	11/14/19	1.0	0.2	35.3	1.2
	11/14/19	11/21/19	0.7	0.2	29.8	1.2
	11/21/19	11/27/19	0.6	0.2	31.3	1.3
	11/27/19	12/04/19	R[2]	R[2]	R[2]	R[2]
	12/04/19	12/10/19	0.4	0.2	27.2	1.2
	12/10/19	12/19/19	0.4	0.1	26.4	1.0
	12/19/19	12/26/19	0.5	0.2	43.0	1.4
	12/26/19	01/02/20	0.9	0.2	45.6	1.4

[1]No sample. Sampler was non-functional on arrival 11/07. Replaced 11/19.
[2]Insufficient sample volume for valid analysis; result was rejected (R).

Table A-1 continued. Weekly concentrations (in 1 x 10^{-3} pCi/m^3) for gross alpha and gross beta analyses for TSP filters for all locations, fourth quarter, 2019.

Sample Location	Collection Date		Gross Alpha		Gross Beta	
	Start	Stop	Concentration	±2 SD	Concentration	±2 SD
Van Buren Avenue[3]	09/26/19	10/03/19	0.6 J	0.1 J	17.9 J	0.5 J
	10/03/19	10/10/19	0.5 J	0.1 J	20.2 J	0.5 J
	10/10/19	10/17/19	0.7 J	0.1 J	32.5 J	0.8 J
	10/17/19	10/24/19	0.5 J	0.1 J	16.8 J	0.5 J
	10/24/19	10/31/19	0.8 J	0.1 J	18.2 J	0.5 J
	10/31/19	11/07/19	1.0 J	0.1 J	41.9 J	0.7 J
	11/07/19	11/14/19	0.8 J	0.1 J	33.6 J	0.7 J
	11/14/19	11/21/19	0.7 J	0.1 J	29.7 J	0.6 J
	11/21/19	11/27/19	0.7 J	0.1 J	31.0 J	0.7 J
	11/27/19	12/04/19	0.4 J	0.1 J	28.1 J	0.6 J
	12/04/19	12/10/19	0.3 J	0.1 J	22.3 J	0.6 J
	12/10/19	12/19/19	0.3 J	0.1 J	18.2 J	0.4 J
	12/19/19	12/26/19	0.6 J	0.1 J	31.8 J	0.6 J
	12/26/19	01/02/20	0.7 J	0.1 J	37.7 J	0.7 J
Boundary Locations						
Atomic City	09/26/19	10/03/19	0.9	0.2	29.3	1.2
	10/03/19	10/10/19	0.7	0.2	33.1	1.2
	10/10/19	10/17/19	1.5	0.3	62.4	1.7
	10/17/19	10/24/19	0.5	0.2	23.3	1.1
	10/24/19	10/31/19	1.6	0.3	39.9	1.4
	10/31/19	11/07/19	2.3	0.3	82.0	1.9
	11/07/19	11/14/19	2.1	0.3	72.2	1.8
	11/14/19	11/21/19	1.5	0.3	51.2	1.5
	11/21/19	11/27/19	1.2	0.3	48.1	1.6
	11/27/19	12/04/19	0.8	0.2	49.1	1.5
	12/04/19	12/10/19	1.1	0.3	50.6	1.6
	12/10/19	12/19/19	1.0	0.2	36.3	1.1
	12/19/19	12/26/19	1.5	0.3	74.3	1.8
	12/26/19	01/02/20	1.6	0.3	77.9	1.8
Howe	09/26/19	10/03/19	0.4	0.2	16.2	1.0
	10/03/19	10/10/19	0.5	0.2	17.9	1.0
	10/10/19	10/17/19	0.8	0.2	31.8	1.3
	10/17/19	10/24/19	0.7	0.2	14.0	0.9
	10/24/19	10/31/19	0.7	0.3	17.7	1.2
	10/31/19	11/07/19	1.0	0.3	37.7	1.4
	11/07/19	11/14/19	1.0	0.3	33.6	1.3
	11/14/19	11/21/19	0.9	0.2	23.6	1.1
	11/21/19	11/27/19	0.9	0.3	30.2	1.4
	11/27/19	12/04/19	0.5	0.2	21.7	1.1
	12/04/19	12/10/19	0.4	0.3	22.8	1.2
	12/10/19	12/19/19	0.4	0.2	19.4	0.9
	12/19/19	12/26/19	R[1]	R[1]	R[1]	R[1]
	12/26/19	01/02/20	NS[2]	NS[2]	NS[2]	NS[2]

[1] Insufficient sample volume for valid analysis; result was rejected (R).
[2] No sample. Sampler was open and covered with snow then would not restart 12/26.
[3] Sampler was calibrated and flowmeter was found to be incorrect. All values were re-calculated based on the calibration data and qualified as estimates (J).

Table A-1 continued. Weekly concentrations (in 1 x 10^{-3} pCi/m^3) for gross alpha and gross beta analyses for TSP filters for all locations, fourth quarter, 2019.

Sample Location	Collection Date		Gross Alpha		Gross Beta	
	Start	Stop	Concentration	±2 SD	Concentration	±2 SD
Monteview	09/26/19	10/03/19	0.6	0.2	19.2	1.0
	10/03/19	10/10/19	0.7	0.2	21.2	1.0
	10/10/19	10/17/19	0.8	0.2	37.3	1.4
	10/17/19	10/24/19	0.9	0.2	17.7	1.0
	10/24/19	10/31/19	0.8	0.2	21.9	1.1
	10/31/19	11/07/19	1.6	0.3	51.2	1.5
	11/07/19	11/14/19	1.4	0.3	45.8	1.5
	11/14/19	11/21/19	1.1	0.3	29.5	1.2
	11/21/19	11/27/19	0.9	0.3	31.0	1.4
	11/27/19	12/04/19	0.6	0.2	34.8	1.3
	12/04/19	12/10/19	0.5	0.3	35.4	1.4
	12/10/19	12/19/19	0.5	0.2	24.5	1.0
	12/19/19	12/26/19	0.7	0.2	27.8	1.2
	12/26/19	01/02/20	0.6	0.2	43.1	1.5
Mud Lake	09/26/19	10/03/19	1.0	0.3	21.8	1.1
	10/03/19	10/10/19	1.0	0.2	29.9	1.2
	10/10/19	10/17/19	1.6	0.3	53.8	1.6
	10/17/19	10/24/19	1.1	0.3	26.4	1.1
	10/24/19	10/31/19	1.1	0.3	32.1	1.2
	10/31/19	11/07/19	1.6	0.3	72.2	1.7
	11/07/19	11/14/19	2.3	0.4	58.0	1.7
	11/14/19	11/21/19	1.5	0.3	43.6	1.5
	11/21/19	11/27/19	1.2	0.3	49.5	1.6
	11/27/19	12/04/19	0.7	0.2	36.9	1.4
	12/04/19	12/10/19	0.8	0.3	43.7	1.6
	12/10/19	12/19/19	0.8	0.2	36.0	1.1
	12/19/19	12/26/19	1.1	0.3	59.2	1.7
	12/26/19	01/02/20	0.9	0.2	50.3	1.5
Distant Locations						
Craters of the Moon	09/26/19	10/03/19	0.4	0.2	16.5	0.9
	10/03/19	10/10/19	0.5	0.2	18.0	1.0
	10/10/19	10/17/19	0.6	0.2	28.5	1.2
	10/17/19	10/24/19	0.4	0.2	12.0	0.8
	10/24/19	10/31/19	0.5	0.2	13.7	0.9
	10/31/19	11/07/19	0.8	0.2	30.5	1.2
	11/07/19	11/14/19	0.6	0.2	25.5	1.1
	11/14/19	11/21/19	0.7	0.2	24.5	1.1
	11/21/19	11/27/19	0.3	0.2	21.5	1.1
	11/27/19	12/04/19	0.5	0.2	19.5	1.0
	12/04/19	12/10/19	0.3	0.2	15.5	1.0
	12/10/19	12/19/19	0.3	0.1	13.5	0.8
	12/19/19	12/26/19	0.5	0.2	21.7	1.1
	12/26/19	01/02/20	0.4	0.2	21.6	1.1

Table A-1 continued. Weekly concentrations (in 1 x 10^{-3} pCi/m^3) for gross alpha and gross beta analyses for TSP filters for all locations, fourth quarter, 2019.

Sample Location	Collection Date		Gross Alpha		Gross Beta	
	Start	Stop	Concentration	±2 SD	Concentration	±2 SD
Fort Hall[1]	09/26/19	10/03/19	0.9	0.2	26.8	1.1
	10/03/19	10/10/19	1.1	0.2	32.0	1.2
	10/10/19	10/17/19	1.5	0.3	55.8	1.6
	10/17/19	10/24/19	0.9	0.2	22.5	1.1
	10/24/19	10/31/19	2.0	0.3	31.6	1.2
	10/31/19	11/07/19	2.1	0.3	66.9	1.7
	11/07/19	11/14/19	2.1	0.3	60.2	1.6
	11/14/19	11/21/19	1.8	0.3	50.7	1.5
	11/21/19	11/27/19	1.3	0.3	40.0	1.5
	11/27/19	12/04/19	0.7	0.2	41.7	1.4
	12/04/19	12/10/19	1.0	0.3	39.4	1.4
	12/10/19	12/19/19	0.8	0.2	32.3	1.3
	12/19/19	12/26/19	1.2	0.3	44.3	1.4
	12/26/19	01/02/20	1.1	0.3	55.5	1.6
Idaho Falls	09/26/19	10/03/19	0.8	0.2	24.1	1.1
	10/03/19	10/10/19	1.2	0.3	30.5	1.2
	10/10/19	10/17/19	1.8	0.3	59.1	1.8
	10/17/19	10/24/19	0.9	0.2	21.0	1.0
	10/24/19	10/31/19	1.1	0.3	25.6	1.1
	10/31/19	11/07/19	2.7	0.4	101.0	2.2
	11/07/19	11/14/19	2.0	0.3	59.0	1.6
	11/14/19	11/21/19	1.6	0.3	44.3	1.4
	11/21/19	11/27/19	1.0	0.3	39.8	1.5
	11/27/19	12/04/19	0.9	0.2	45.7	1.5
	12/04/19	12/10/19	0.6	0.3	39.5	1.5
	12/10/19	12/19/19	0.6	0.2	27.5	1.0
	12/19/19	12/26/19	1.1	0.3	56.9	1.6
	12/26/19	01/02/20	1.1	0.3	58.6	1.6

[1]Sampler owned and operated by the Shoshone-Bannock Tribes.

Appendix B

Table B.1. Results for all electret ionization chamber (EIC) locations, fourth quarter, 2019.

Sample Location	Net Corrected Exposure Rate (µR/hr)[1]	± 2 SD (µR/hr)
Arco	12.1, 13.1	-
Craters of the Moon	12.5	3.0
Rest Area	12.2	1.7
Van Buren Avenue	16.6	1.8
Experimental Field Station	16.3	1.7
Main Gate	16.1	2.1
Atomic City	12.6	1.0
Taber	11.1, 11.6	-
Blackfoot	13.5	1.6
Ft. Hall	11.6	1.9
Idaho Falls	7.2, 8.9	-
Mud Lake/ Terreton	12.4, 13.4	-
Monteview	13.8, 15.6	-
Sand Dunes	15.1	2.7
Howe Met. Tower	10.8	2.2
MP282 -20	12.1	0.5
MP280 -20	13.7, 14.5	-
MP278 -20	10.7	3.4
MP276 -20	11.7	0.6
MP274 -20	10.5	1.5
MP272 -20	8.1, 9.5	-
MP270 -20	10.2, 11.9	-
MP268 -20	12.4	3.6
MP266 -20	11.9, 12.8	-
MP264 -20	15.1, 17.6	-
MP270 -20/26	15.0	0.7
MP268 -20/26	16.6, 16.8	-
MP266 -20/26	15.5	0.9
MP263 -20/26	12.5	2.7
MP261 -20/26	11.5	2.5
MP259 -20/26	13.1	2.4
MP256 -20/26	10.9	1.3
MFC (EBR II)	13.2	1.9
EBR I	12.3	0.7
RWMC	12.0, 12.9	-
CFA	16.0	1.4
CITRC (PBF)	10.9	2.1
INTEC	17.2	1.1
ATR (TRA)	11.4, 13.2	-
NRF	12.6, 14.9	-
TAN/SMC	12.6, 12.9	-
Mud Lake Bank of Commerce	13.9	2.9
MP43-33	12.3, 13.4	-
MP41-33	11.9, 13.4	-
MP39-33	11.9	1.4
MP37-33	8.6	3.1
MP35-33	12.0	0.3
MP33-33	14.2, 16.1	-
MP31-33	10.8	1.3
MP29-33	20.3	3.4

Table B.1. continued. Results for all electret ionization chamber (EIC) locations, fourth quarter, 2019.

Sample Location	Net Corrected Exposure Rate (μR/hr)[1]	± 2 SD (μR/hr)
MP27-33	10.0	2.4
MP25-33	13.7	3.1
MP23-33	11.5	2.2
MP21-33	13.6, 13.7	-
MP19-33	16.4	2.1
MP14-33	10.6	3.4
MP11-33	11.8	3.2
MP06-33	10.6	0.4
MP03-33	8.5, 9.6	-
Base of Howe	9.8, 10.6	-
Rover	10.9	2.6
Hamer	14.4	1.2
Sugar City	11.6, 13.8	-
Roberts	11.0	2.9
Big Southern Butte	10.0	1.2
T4 North	16.3	1.5
MP27-33	10.0	2.4

[1]Results are the average of triplicate exposure rate measurements with the associated sample variability (±2 SD), or the 2 measured exposure rates remaining after removal of an outlying value. One of the triplicate measurements is rejected if it is outside the average of the triplicate measurements ±2 SD of the historical population variability. Typically, the two most consistent measurements are reported, based on judgment of the data analyst.

Appendix C

Table C-1. List of volatile organic compounds (VOCs) analyzed for water samples.

Analyte	Minimum detectable concentrations (MDC) (expressed in µg/L)
Benzene	0.5
Carbon tetrachloride	0.5
Chlorobenzene	0.5
1,4-Dichlorobenzene	0.5
1,2-Dichlorobenzene	0.5
1,2-Dichloroethane	0.5
1,1-Dichloroethene	0.5
cis-1,2-Dichloroethene	0.5
trans-1,2-Dichloroethene	0.5
1,2-Dichloropropane	0.5
Ethylbenzene	0.5
Methylene Chloride	0.5
Styrene	0.5
Tetrachloroethene (PCE)	0.5
Toluene	0.5
1,2,4-Trichlorobenzene	0.5
1,1,1-Trichloroethane	0.5
1,1,2-Trichloroethane	0.5
Trichloroethene (TCE)	0.5
Vinyl chloride	0.5
Xylenes (total)	0.5
Bromodichloromethane	0.5
Dibromochloromethane	0.5
Bromoform	0.5
Chloroform	0.5
Bromobenzene	0.5
Bromochloromethane	0.5
Bromomethane	0.5
n-Butylbenzene	0.5
sec-Butylbenzene	1.0
tert-Butylbenzene	0.5
Chloroethane	0.5
Chloromethane	0.5
2-Chlorotoluene	0.5

Table C.1 continued. List of volatile organic compounds (VOCs) analyzed for water samples.

Analyte	Minimum detectable concentrations (MDC) (expressed in µg/L)
4-Chlorotoluene	0.5
1,2-Dibromo-3-chloropropane (DBCP)	0.5
1,2-Dibromoethane (EDB)	0.5
Dibromomethane	0.5
1,3-Dichlorobenzene	0.5
Dichlorodifluoromethane	0.5
1,1-Dichloroethane	0.5
1,3-Dichloropropane	0.5
2,2-Dichloropropane	0.5
1,1-Dichloropropene	0.5
cis-1,3-Dichloropropene	0.5
trans-1,3-Dichloropropene	1.0
Hexachlorobutadiene	0.5
Isopropylbenzene	0.5
p-Isopropyltoluene	0.5
Methyl Tert Butyl Ether (MTBE)	0.5
Naphthalene	0.5
n-Propylbenzene	0.5
1,1,1,2-Tetrachloroethane	0.5
1,1,2,2-Tetrachloroethane	0.5
1,2,3-Trichlorobenzene	0.5
Trichlorofluoromethane	0.5
1,2,3-Trichloropropane	0.5
1,2,4-Trimethylbenzene	1.0
1,3,5-Trimethylbenzene	0.5